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Electronics Australia

SEPTEMBER 1988
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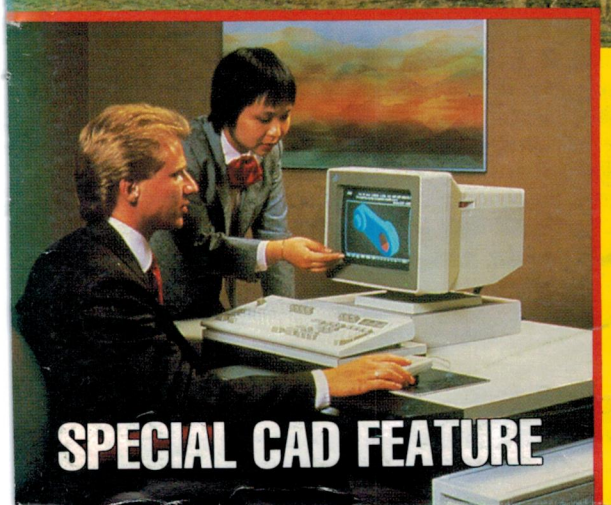
AUSTRALIA'S EXCITING NEW RADIO TELESCOPE



SPECIAL CAD FEATURE

NEW CHIP FOUNDRY OPENS IN SYDNEY

PROJECTS TO BUILD:
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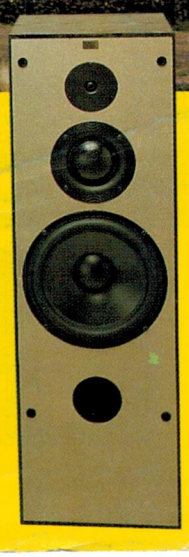
72-L SPEAKER SYSTEM ▶



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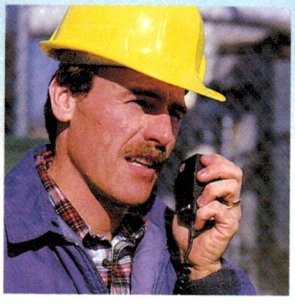

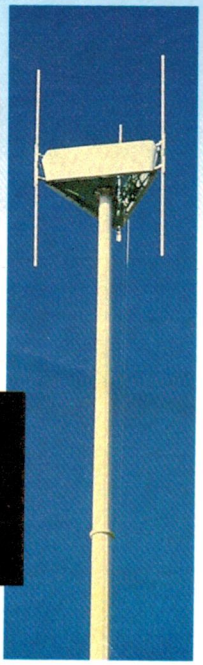

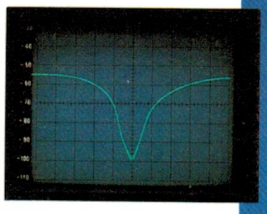

Don't tinker around! Buy IFR, the monitors that make the others seem like toys.

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R.A. Penfold **BP0076**

The purpose of this book is to give a number of power supply designs, including simple unstabilised types, fixed-voltage types, and variable-voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low-voltage types for semiconductor circuits. This book should also help the reader to design his own power supplies.

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R.A. Penfold **BP233**

A handy data reference book, written especially for the newcomer to electronics. Provides data on component colour codes, IC families, basic power supply circuits, circuit symbols, op-amp connections, testing transistors and SCRs, basic computer interfaces, morse code and lots more.

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B.B. Babani **BP0160**

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CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS

M.H. Babani B.Sc (Eng) **BP0027**

Illustrates the common, and many of the non-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc. in most countries throughout the world.

Chart **$4.00**

HOW TO DESIGN ELECTRONIC PROJECTS

R.A. Penfold **BP0127**

The aim of this book is to help the reader to put together projects from standard circuit books with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements where no "stock" design is available are also provided.

128 pages **$9.00**

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING

R. A. Penfold **BP0110**

The aim of this book is to help the reader overcome problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

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AUDIO AMPLIFIER FAULT-FINDING CHART

C.A. Miller **BP120**

A very useful fold-out chart which will guide almost anyone in tracking down faults in audio amplifiers, systematically and quickly. Includes detailed notes.

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IC 555 PROJECTS

E.A. Parr **BP0044**

Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are basic and general circuits, motorcar and model railway circuits, alarms and noise-makers as well as a section on 566, 568 and 569 timers.

$9.50

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART

B.B. Babani **BP0007**

Covers many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field costs, fuses, battery leads, speakers, etc.

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R.A. Penfold **BP0185**

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112 pages **$11.00**

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS

R.A. Penfold **PB0179**

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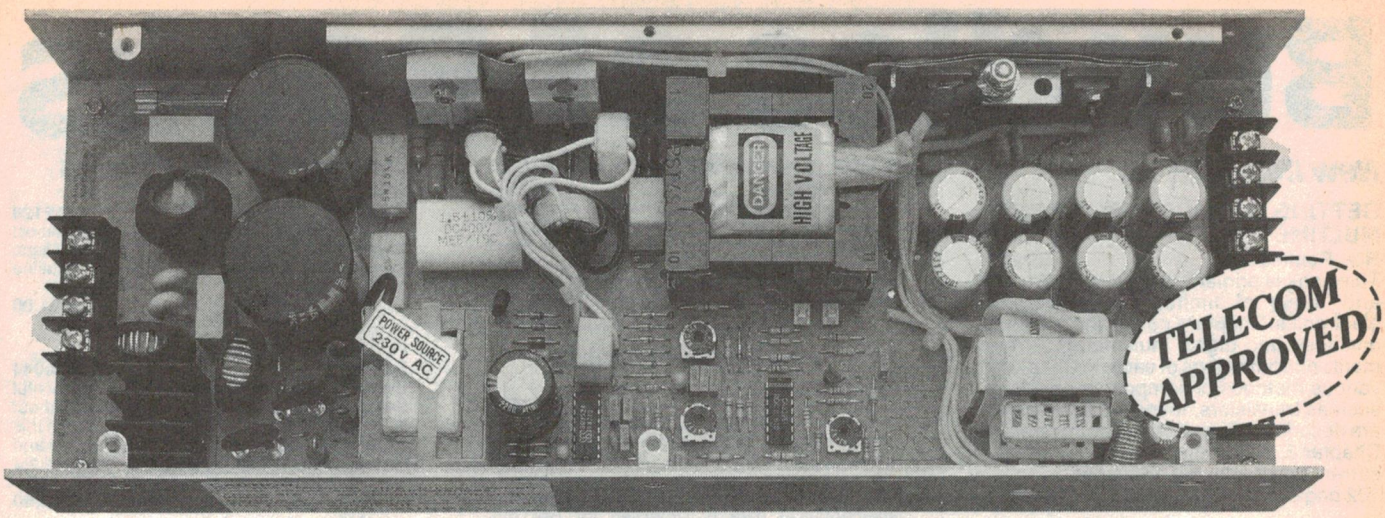

Shown with cover removed

Shown above is model UN1300-48ABC. This is a 300W single output supply with 48V @ 6.5A from a 90-132V/180-264V, 47-440Hz AC input. Full overvoltage, overcurrent, short circuit and thermal protection is built in. It is approved by Telecom (No. RA87/112)

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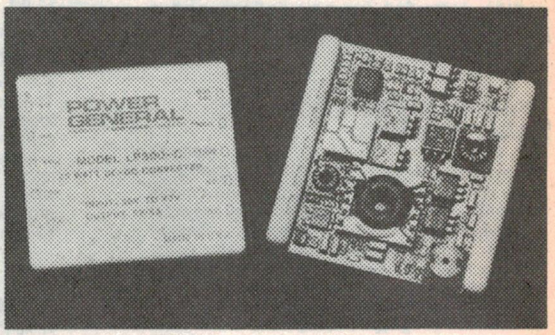

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JBA 203

Volume 50, No.9

Electronics Australia

September 1988

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Australia's newest radio telescope

Australia has always been at the forefront of radio astronomy, and this month sees our scientists take another leap forward with the opening of the massive Australia Telescope. *See p12.*

Projects to build

Our construction projects this month include an improved 72-litre 3-way loudspeaker system,- full assembly details for our new Playmaster 30W per channel stereo amplifier (at last!), a simple current source for making very low resistance measurements with your DMM, and a low cost and very easy to build electronic stud finder.

CAD feature

This month's special feature on computer-aided design includes a story on IBM's new CAD package for PCB design, a run-down on the latest CAD products and a review of a new low-cost CAD package for IBM PCs and compatibles. *See p106.*

ON THE COVER

Our main shot this month shows three of the dish antennas for the new Australia Telescope array at Culgoora, in northern NSW. As our feature starting on page 12 explains, the telescope begins operating this month. (Picture courtesy CSIRO).

Features

Entertainment Electronics

Projects and Technical

News and Comment

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P.O. Box 227, Waterloo 2017.
Phone: (02) 693 6620
Fax number: (02) 693 2842 Telex: AA74488
For reader services see back of magazine.
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ELECTRONICS AUSTRALIA is published monthly by Brehmer Fairfax Pty. Ltd., Double Bay Newspapers Pty. Ltd. and General Newspapers Pty. Ltd. trading as Federal Publishing Co., 180 Bourke Road, Alexandria, N.S.W. 2015.

Typeset and printed by Hannanprint, 140 Bourke Road, Alexandria, NSW for The Federal Publishing Company Pty Ltd.
Distributed by Newsagents Direct Distribution Pty Ltd, 17 Doody Street, Alexandria NSW 2015
Registered by Australia Post – publication No. NBP 0240 ISSN 0313-0150
*Recommended and maximum Australian retail price only.

Letters to the

Electronic typewriters

Thanks for printing the letter on "Electronic Typewriters" in the May issue of "E.A.". I hope you open a "can of worms" and receive many dozens of letters regarding these chines from other users.

I am typing this letter on one such machine. Like your correspondent, it does seem a pity that these lovely little machines are treated with contempt by so many sales-persons. I would guess profit motive would be one factor. One would not have to be a genius to realise that a $1500+ word processor is much more profitable (for the retailer) than a $300 "typewriter".

As regards "usability", well-there are more features than the average person would want in ten life-times! Most keys have four different "functions". For instance, the "L" key gives me "l" "L", "β" and "Ω".

There are one or two "negatives" that come with using such a "luxury" machine, though. The machine is monocell powered but the consumption is so high (7.6W) that the use of the (optional) mains-adaptor is essential. Also, the ribbon is a "one-time" type in a cassette. These cassettes are both virtually unobtainable and very expensive ($10). I use my machine rather a lot and a ribbon lasts around 2 months.

All in all, I would be "lost" without this machine. I previously had a manual machine which I used only very occasionally. This machine is used almost every day. It is luxury "par excellence"!

Terry Robinson, VK3DWZ
Woodend, Vic

Fax for servicemen?

The suggestion raised in your Serviceman column regarding a fax users group (May 1988) is a very interesting and worthwhile proposition. However, who will it actually benefit? Are servicemen the only ones able to join in? Admittedly, it would help customers in the long run, due to the fact that servicemen would have an immediate linkup with each other to obtain circuit diagrams and information about parts availability and prices. But how many servicemen have access to fax machines?

What I have wished for in the past is some means by which the public can liaise with servicemen and companies in order to obtain information. I have been trying to get a circuit diagram for an HMV Braddon 18 television. I received this when buying a second hand computer, and was told that it went in for servicing, but due to the owner not wanting to add to the cost of the computer setup, he included it in the setup for nothing. He said something about a transformer not working. I spent a period of time working for Dixon's TV Service in New Lambton, Newcastle, and in that time I was following circuit diagrams around, locating faults, and doing repairs, and most of them can be easily pinpointed with the aid of a circuit diagram (but not all – you wouldn't have a column to write if they were!). I also have a tape deck at home that needs to have the headphone socket replaced – an easy job if I could just get the part.

Obviously what is needed is some sort of service that could fulfil these purposes. The companies probably wouldn't agree with this saying that it would take away servicing fees from them, and it could result in disaster if an unqualified person was to jump in at the deep end.

I'm not sure how such a system could be set up, perhaps like the Electronics Australia photocopy service; pay a small fee for the relevant information. The next problem would be how to obtain the parts, how does a large company like being asked for one component? Of course, it could be sent to a serviceman with a note attached giving a possible cause. If the diagnosis was correct, it would save a lot in labor costs. Perhaps you could stir a bit of interest in this subject, or let us all know an easy way of obtaining things that have been previously only available to a select few.

Michael Dobbins
Charlestown, NSW

Comment: Thanks for your response, Michael. A company called JR Publications used to market circuits, but we haven't heard from them for some time.

Made in Australia

Because of a lack of the "ready's", I do not buy Electronics Australia every month, but I do manage to get six to eight copies a year. Luckily for me I did get the May 88 issue, because your Editorial Viewpoint was enlightening for me.

editor

For the past ten years I have been operating a cottage industry in speaker and amplifier making, and although I have never met Peter Stein in person, we are on speaking terms over the phone.

Also, over the past ten years I have on several occasions expressed interest in various installations in the general area in which I live, but have been given the "heave ho".

One chap told me bluntly that unless I wined and dined the people that made money spending decisions, then to forget making any approaches at any time, either now or in the future. After seeing the real world in the audio business especially in the cities, then I can see that this is the norm.

Well, for me it is not to be that way, so I just plod along in my own way, and rely entirely on word of mouth and very satisfied customers.

During my lifetime I have been lucky enough to be privy to the various reasons why things, by things I mean tariffs, taxes, licenses and other things to do with government offices, are done in this country. At the time I was doubfounded, but it eventually sunk in.

The crux of this letter is to say that I support Peter and any others who wish to thrust the Australian Audio industry into a better understood picture, expressly in the buying public domain.

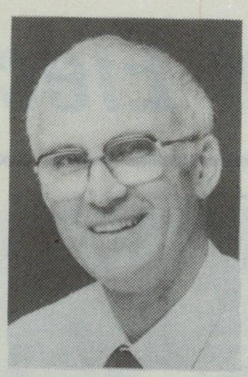
At one time I almost signed an agreement to purchase compact disc drives and make my own but the outlay, both to the manufacturer & others who could give the go-ahead was too much for me, and so another possible gain was lost, perhaps forever.

G.R. Druery,
Nambucca Heads, NSW

Appliance earthing

After rereading your February and April Forums, I conclude that what the SAA and others are trying to say is that the mains earth pin in the household socket (or extension cord) is a highly unreliable source of earth potential and to be avoided where possible. This point, I believe, needs stressing where electronic equipment is involved.

Under leakage or fault conditions the mains earth potential can rise to dangerous levels, and I once received a shock from the earth stake of an old house



Editorial Viewpoint

How is YOUR hobby project coming along?

In case you've forgotten, this is the third and final month for entries to our **Grand Aussie Hobby Electronics Competition**. So if you want *your* pet project to be in the running for one of those beaut prizes donated by Dick Smith Electronics, you'll need to send it in by September 30 (or postmarked no later than that date).

We haven't had too many project entries so far, but I imagine you've all been busy working on them and making sure they perform as intended. On past experience I expect a lot of entries to come in just before the end of the month - three months isn't all that long to develop a worthwhile project, after all.

Don't forget that we have over $3500 in prizes to be won. First prize in both the newcomer and advanced hobbyists' sections is over $1500 worth of test gear, in each case the kind of equipment that most hobby enthusiasts can only dream about. And there are runner-up prizes in each section, of DSE Components Vouchers worth $100 - very handy indeed.

Incidentally if you haven't yet taken advantage of Dick Smith Electronics' offer on a 10% discount for all components purchased to develop your competition project, there's a discount voucher printed again in this issue on page 93. Note that there's no limit to the value of parts you can buy using the voucher, providing you buy them in the one purchase.

We're hoping to announce the winners in the December issue, and publish their designs in the same issue as well. It could be your design!

Changing the subject, we've been working very hard this last month to try and catch up with magazine production after last month's terrible fire. I hope this issue will reach you almost on time, all going well, and by next month we should be back to normal. We're sorry for any inconvenience our unavoidable lateness may have caused.

On the brighter side, it was very cheering this last month to hear from and meet Arthur Mead VK2JM, who has been reading the magazine ever since it began as *Wireless Weekly* back in 1922. As we report in News Highlights, Mr Mead heard that we were looking for very early copies of the magazine, and has generously presented us with bound copies of *Wireless Weekly* Volumes 1 and 3. It was a splendid gesture, and one that was really heartwarming after some of the setbacks we've had lately.

Now *there's* a reader which any magazine editor would be proud to have, don't you think? I know I am.

Jim Rowe

What's New In Entertainment Electronics

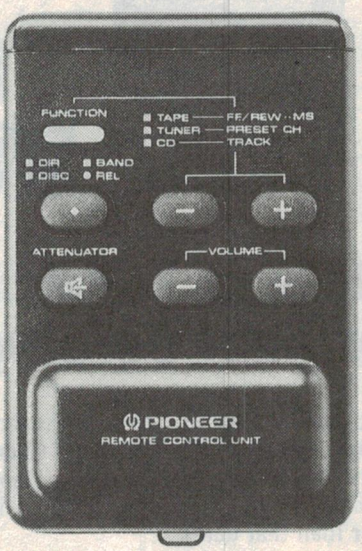
Boot-mounted car CD player from Pioneer

Pioneer Electronics claims that its new CDX-M100 multi-play compact disc player demonstrates confidence in the future of in-car CD technology, and that it incorporates developments which are a milestone for driver convenience. The CDX-M100 utilises a six disc magazine (JD-M100 supplied with the unit) providing up to six hours of uninterrupted music. The magazine is compatible with Pioneer's multi-play home models and can be easily slipped from the lounge room stereo into the car.

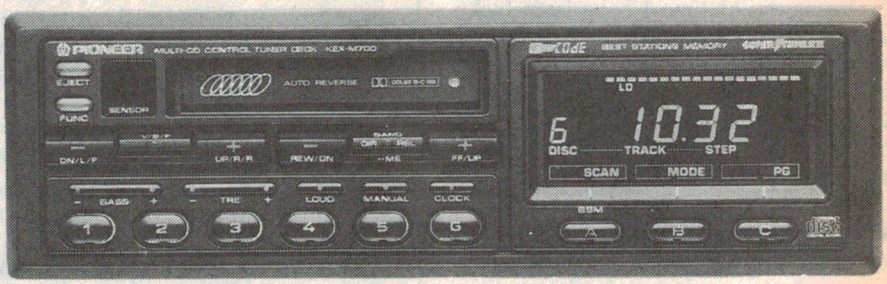
The positioning of the CDX-M100 in the car boot eliminates the need to handle discs while driving, a substantial safety feature. The CDX-M100 mechanism floats on air damper suspension, avoiding potential mis-tracking as a result of rough roads. (This "double float" anti-vibration suspension is similar to that used in buses). Valuable discs are well protected.

The CDX-M100 features AMPS (Auto Magazine Programme Selection) for continuous music selection and other desired functions including Versatile Play modes, track search, track scan, music repeat, programme play, random play, compact three beam laser pick-up and fast forward and reverse.

The pre-programmed six disc music selection loaded into the boot-mounted CD unit is controlled by Pioneer's two new dashboard-mounted command units – the KEX-M700 or the DEX-M300.



Above is the CDX-M100, which mounts in the boot. Below is the KEX-M700 dash-mounted tuner/cassette/command unit, with the remote control at upper left.



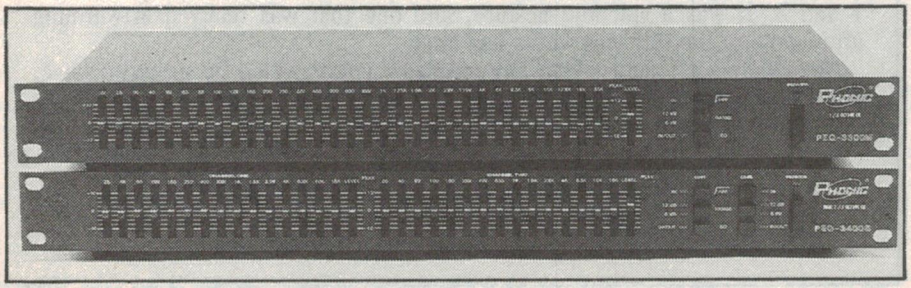
The KEX-M700, a single DIN-sized unit controlling all three sources is an industry first and offers a high quality cassette deck and Quartz-PLL Supertuner with an extensive array of desired features.

Alternatively, the DEX-M300 component Quartz-PLL Supertuner may be used to drive the Multi-Play Compact Disc unit. This model also features many of the benefits of the KEX-M700 with the added Detachable Controller facility.

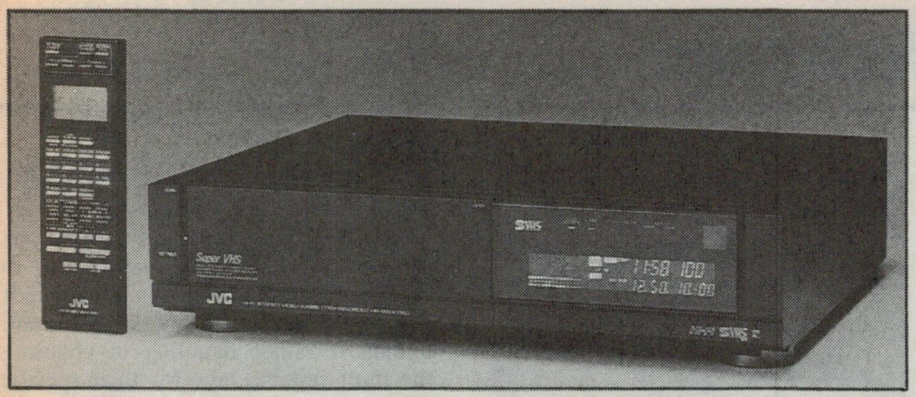
New graphic equalizers

Two new professional standard graphic equalizers, designed in Australia and manufactured in Taiwan have been released by Sydney based PA specialist, Freedman Sound.

The Phonic PEQ-3300M and the PEQ-3400S incorporate features generally found on more expensive models such as low noise, balanced input and output, 6 or 12dB selector switch, high pass filter and EQ by-pass switch. Both are 19" rack mount units.



Specifications are 6Hz to 85Hz frequency response; 0.01% total harmonic distortion; 1V/22k ohms input sensitivity; 1V/600 ohms output. Maximum output is 8.5V RMS and noise-for-band gain set at 0dB is 0.26mV, at −12dB is 0.4mV and at +12dB is 2.2mV. The PEQ-3300M is the mono model with 31 control frequencies between 20Hz and 20kHz. The PEQ-3400S is stereo and has 15 control frequencies between 25Hz and 16kHz on each channel.



JVC releases first S-VHS VCR in Australia

Super VHS delivers more than 400 lines of horizontal resolution, a dramatic improvement made possible by recording the luminance signal in a higher and broader carrier frequency band. An equally significant improvement in the S/N ratio has been achieved by expanding the frequency deviation and using a non-linear sub-emphasis system. And, for the best possible colour reproduction, Super VHS incorporates a separate luminance (Y) and chrominance (C) signal processing method to reduce interference between signal components.

The HR-S5000 features an open-out control panel that doubles as a cassette-slot cover and a thick acrylic window to protect the fluorescent display panel.

To ensure that none of the potential Super-VHS quality is lost, the HR-S5000 has a built-in wide bandwidth tuner capable of detecting a much wider range of video signal frequencies than before. And, for the best-possible picture quality in both the SP and the LP modes, a Super Double-Azimuth 4-Head (Super DA-4) combination video head system – based on JVC's tested and proven Double-Azimuth 4-Head (DA-4) system – had been incorporated. First-rate picture quality in VHS recording and playback is also ensured by HQ (High Quality) picture improvement circuits.

For the ideal audio counterpart to its Super VHS picture, the HR-S5000 offers top quality VHS Hi-Fi Stereo sound. Two rotary FM-audio heads combined with an advanced L/R channel independent switching noise reduction circuit provide sound reproduction that is vastly superior to conventional audio tapes..

The HR-S5000 can also function as an editing recorder of near-professional quality, incorporating a flying erase head for precise insert editing and the Zero Frame Editing system for assemble editing. An audio dubbing circuit is also provided.

DSE selling Sanyo Vision 8

Because most video recorders and players have been basically the same, Dick Smith Electronics has kept clear of the video market altogether until very recently. But now the company is selling the new Sanyo Vision 8 video system.

Weighing in at just 1.27kg and with a very compact design, the Sanyo Vision 8 Camcorder is claimed to be the easiest to handle video camera on the market today.

It provides 1/1500th second electronic shutter speed, giving extra sharp, crystal clear slow and still playback. A new high resolution image sensor allows camera operating illumination to be cut to as low as 9 lux.

With advanced Digital Auto Focus, backlight compensation, auto white balance, 6X zoom, macro that allows focus as near as 5mm, and manual focus selection, DSE claims that anyone can get superb quality images without fuss or bother.

To complement the Vision 8 Camcorder, Dick Smith Electronics also stocks the Sanyo Digital Picture VHS remote control video cassette recorder. This allows you to get up to nine frames on the one screen simultaneously, to zoom to a specific frame, add effects such as mosaic and picture paint, or watch the TV in one corner of the screen while a video plays in the rest.

Just to complete the picture, Dick Smith Electronics also carry the Sanyo Simple & Smart monitor look 34cm (14") colour TV.

The Sanyo Vision 8 Camcorder (Cat G-5200) retails for $2499, the Digital VCR (Cat G-5100) for $499. All are available through any Dick Smith Electronics store.

Entertainment Electronics

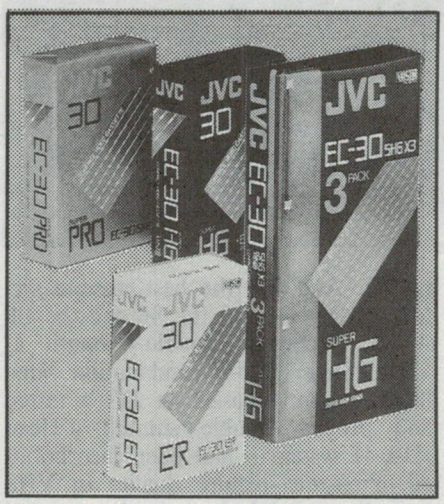
New video tapes from JVC

JVC has released a new range of video tape claimed to meet a more individual need of users.

For every day use JVC's ER tape is available in five different lengths, ranging from 30 minutes up to four hours of recording. The ER tape has super fine magnetic particles with a BET value of 32m2/g and improved cassette mechanism and increased durability.

JVC's Super Pro, according to the company, "raises every performance parameter to previously unattainable levels". Featuring the JVC developed MBV (Multiphase Bari-Fero) emulsion that incorporates barium ferrite, Super Pro tape features perpendicular magnetising of ultra-fine magnetic particles. This is claimed to produce an ideal mix for complex signals used in video recording systems resulting in superior colour expression, improved edge and increased resolution.

Catering for the increase in audio/video recording, JVC's Super High Grade Hi-Fi tape is said to combine the best in picture and audio reproduction. For those more intent on a superb video reproduction at an affordable price, then Super High Grade video tape, according to JVC, is the answer.



TDK video tape grading

Choosing one grade of video tape from another is now easier thanks to TDK's new grading system. TDK felt that previously consumers were still finding it rather daunting in choosing the most suitable tape for their specific needs. Price had been the major yardstick in determining their tape selection.

In an effort to change this perception, TCK is endeavouring to raise consumer awareness in the different tape grades, and that the buying decision should not be based purely on price, but on quality and long term value for money.

With the recent release of a new video tape line up, TDK invented a totally new way of judging tape performances more accurately. Called " a Picture Purity Index" a numeric figure shows the differences in such properties as: luminance S/N, chrominance S/N (AM), and chrominance S/N (PM).

Audio and video test tapes

Sydney audio components specialist Wagner Electronics has released a range of test tapes for both audio and video cassette recorders. The test on the tapes vary in complexity from a simple test of tape speed to everything necessary for the professional to align the record/playback heads.

The AAC9 is an Australian-made audio test tape for the hi-fi enthusiast and audio tradesman. A range of test can be performed without other test equipment or technical knowledge, the most useful one being a test of tape speed. The tradesman user is encouraged to use this tape so as not to risk damage of proper alignment and test cassette tapes. The first six minutes of the tape is a 1kHz sine wave, the next six minutes a 5kHz sine wave, then a 2.5kHz sine wave suppressed for 10 seconds every 10 seconds. Cost is $19.95.

The LC Engineering range is a more advanced imported range aimed at the audio tradesman. Each tape is a master, not a duplicate, and each is individually produced, tested and numbered. There are six models which test head alignment, tape speed, signal-to-noise ratio and wow and flutter. They are priced from $36 to $39.95.

system

According to TDK the "Picture Purity Index" method is not only more accurate, but the results are more understandable than any other simplified measuring system for consumer video tapes on the market.

To understand the PPI classificaton the three basic measures 、 ideo tape picture quality are thus defined:

1) luminance S/N; a measure of picture brightness and sharpness.

2) chrominance S/N (AM): a measure of video colour saturation and colour vividness.

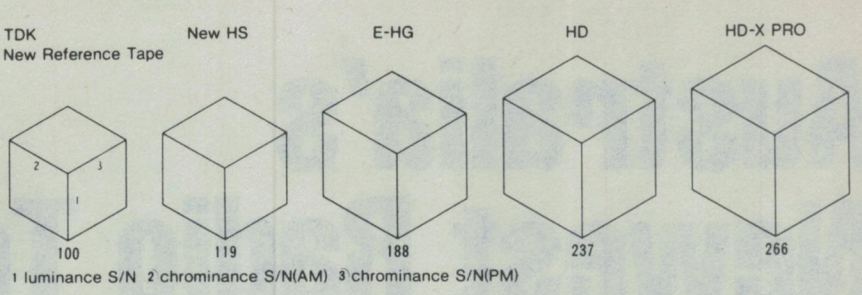
3) chrominance S/N (PM); a measure of colour trueness and is often referred to as tone fidelity or hue.

The PPI = (1) x (2) x (3) x 100

These measurements are compared to TDK's new reference tape.

From the table you can see that TKD's new HS has a PPI of 119 and its HD-XPRO has a PPI of 266. TDK further claims that at a glance consumers can see the major differences between each tape grade. This simplified method of determining the differences in tape grades should help in the choosing of a tape such as for the recording of a cricket match or the demanding applicatons as original mastering.

●"Cubic" Comparison of Picture Purity



1 luminance S/N 2 chrominance S/N(AM) 3 chrominance S/N(PM)

●Picture Purity Indexes for TDK Video Cassette Tape

tape / picture purity factor	TDK New Reference Tape	New HS	E-HG	HD	HD-X PRO
factor 1 luminance S/N (brightness picture sharpness)	0dB (×1.0)	+0.5dB (×1.06)	+2.0dB (×1.26)	+3.0dB (×1.41)	+3.5dB (×1.50)
factor 2 chrominance S/N(AM) (color saturation vividness)	0dB (×1.0)	+0.5dB (×1.06)	+2.0dB (×1.26)	+2.5dB (×1.33)	+3.0dB (×1.41)
factor 3 chrominance S/N(PM) (hue tone fidelity)	0dB (×1.0)	+0.5dB (×1.06)	+1.5dB (×1.19)	+2.0dB (×1.26)	+2.0dB (×1.26)
Picture Purity Index: 1 × 2 × 3 ×100	100	119	188	237	266

Local hi-tech electronics at heart of

Australia's Newest Radio Telescope

On September 2nd at the Paul Wild Observatory in the NSW country town of Culgoora, west of Narrabri, the Australia Telescope will be officially declared "open for business". This will usher in a new and exciting era for Australia's radio astronomers, because this $50 million facility is a radio telescope *par excellence*, designed to satisfy their research needs into the next century. And for its successful operation, the astronomers will rely heavily on hi-tech electronics designed and manufactured locally.

by DR JOHN B. WHITEOAK
Australia Telescope Project Secretary

The Federal Government finally approved the Australia Telescope project in November 1983, giving CSIRO Division of Radiophysics the responsibility for its construction. After September the Division will host the telescope, which will operate as a national facility available, on merit, to scientists from all over Australia.

What precisely is the Australia Telescope? It is a collection of eight radio dish antennas, located at three sites in NSW, which will be linked in two basic configurations – the Compact Array (CA) and the Long Baseline Array (LBA). The first, which has risen like a phoenix from the "ashes" of the famous but retired radioheliograph at the Paul Wild Observatory, consists of six new 22-m dish antennas. Five of these can be moved along a 3-km east-west railtrack to any of 35 observing "stations". The sixth antenna is located on a small railtrack with only two stations, a further 3km to the west.

For observation each antenna is set (to an accuracy of a few millimetres) on to one of these stations. By varying the selected stations between observations, the distances between antennas can be varied.

The other configuration, the LBA, is formed by using the CA antennas together with a seventh 22-m antenna constructed at Mopra, a few kilometres west of Coonabarabran, (and very close to Siding Springs) together with the famous Parkes 64-mm antenna, 320km south of Culgoora.

Why an array?

During the 1960's Australian radio astronomers had built a series of fine radio telescopes, and although they are still providing useful results they cannot provide images of radio sources with the fine detail needed to solve many current astrophysical problems (such as the nature of the centre of our galaxy).

Generally speaking, the larger an antenna, the finer the detail discerned. A single antenna cannot be built large enough to provide the detail that astronomers now require, but this detail can be achieved using several linked antennas.

Using a technique (called "earth-rotation synthesis") that Australian radio astronomers developed for observations of the Sun during the 1950s, astronomers can produce radio source images with the same detail achievable by a single antenna with a diameter equal to the maximum separation between pairs of antennas in the array. Ideally, the technique requires a large range of spacings between individual antennas, and long periods of observation. The six antennas of the CA provides 15 spacings at any instant, and full simulation of a 6km antenna requires many changes of antenna positions.

The 6km CA will "see" detail 100 times finer than with the Parkes telescope alone, while detail 50 times finer still will be possible with the LBA. And in the future even finer detail will be observable. The Australia Telescope will be linked with other antennas around Australia, in other countries, and even in orbit, to form giant arrays with maximum spacings of thousands, even tens of thousands, of kilometres.

Test observations combining ground-based and orbiting Tracking and Data Relay Satellite System (TDRSS) antennas have already proved successful, and some time ago the USSR initiated a project, RADIOASTRON, to launch a 10-m antenna into space by 1992. Along with other countries, Australia has joined in the project, the Prime Minister recently signing a Memorandum of Understanding concerning the provision by Australia of some of the antenna equipment.

Another space project, QUASAT, concerning the launch of a 15-m antenna by 1996, is being planned by overseas space agencies, and Australia will play a key role in providing southern hemisphere antennas.

The fine detail achievable with such arrays should provide considerable insight on "black holes", those elusive massive objects believed to dominate the dynamics near the centre of galaxies, and triggering the large distributions of radio emission associated with some objects.

The new antennas

The CSIRO Division of Radiophysics, working in conjunction with local consultant engineers Macdonald Wagner, produced cost-effective designs for the new 22-m antennas. The Culgoora antennas have a large azimuth slewing ring with widely-separated elevation bearings, an intermediate mounting of open

The five closely-spaced dish antennas at Culgoora, nearing completion. When finished and operational they will be deployed along 3km of tracks, with a sixth dish 3km further west.

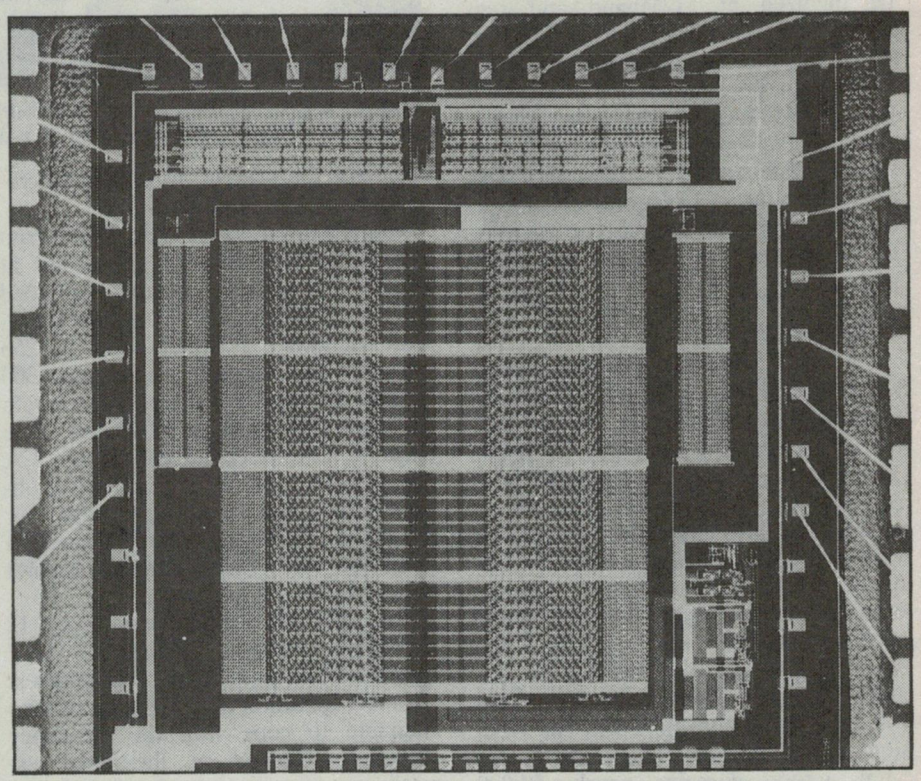
trusswork, a stiff backup structure, and a heavy base equipped with bogeys. For the Mopra antenna, which is not mobile, a simpler "wheel-on-track" design was adopted.

The reflecting surface contains four rings of solid panels and two of perforated panels. The Division developed a simple, low-cost method of panel construction which has produced solid panels accurate to 0.15 mm. The antennas were fabricated and erected by one-time Brisbane shipbuilding firm Evans Deakin Industries, in a $15 million contract.

The experience gained from the anntenna design has already been used to support Australian industry – in the design of two 18-m earth-station antennas that Johns Perry Ltd of Adelaide recently constructed for OTC.

Wavelength bands

The project budget will provide for operation in wavelength bands near 20,11,6 and 3cm (1.5, 2.7, 5 and 10 GHz). The beamwidth scales with wavelength, and for the Compact Array the smallest (at 3cm) will be 0.8 second of arc. This is about the same as the reso-



A close-up of one of the correlator chips used in the Australia Telescope correlator. Thousands of these Australian-made chips are used, each containing nearly 50,000 transistors.

lution of Australian optical telescopes during good observing conditions, and is equivalent to reading a telephone directory from a distance of 200 metres. The wavelength range will be expanded later to include other bands between 90cm and 2.6mm.

The bands were selected not only to enable the "continuum' emission spectrum of radio sources to be sampled at approximately octave intervals, but also to include the discrete, narrowband signals from important atoms and molecules in the interstellar medium.

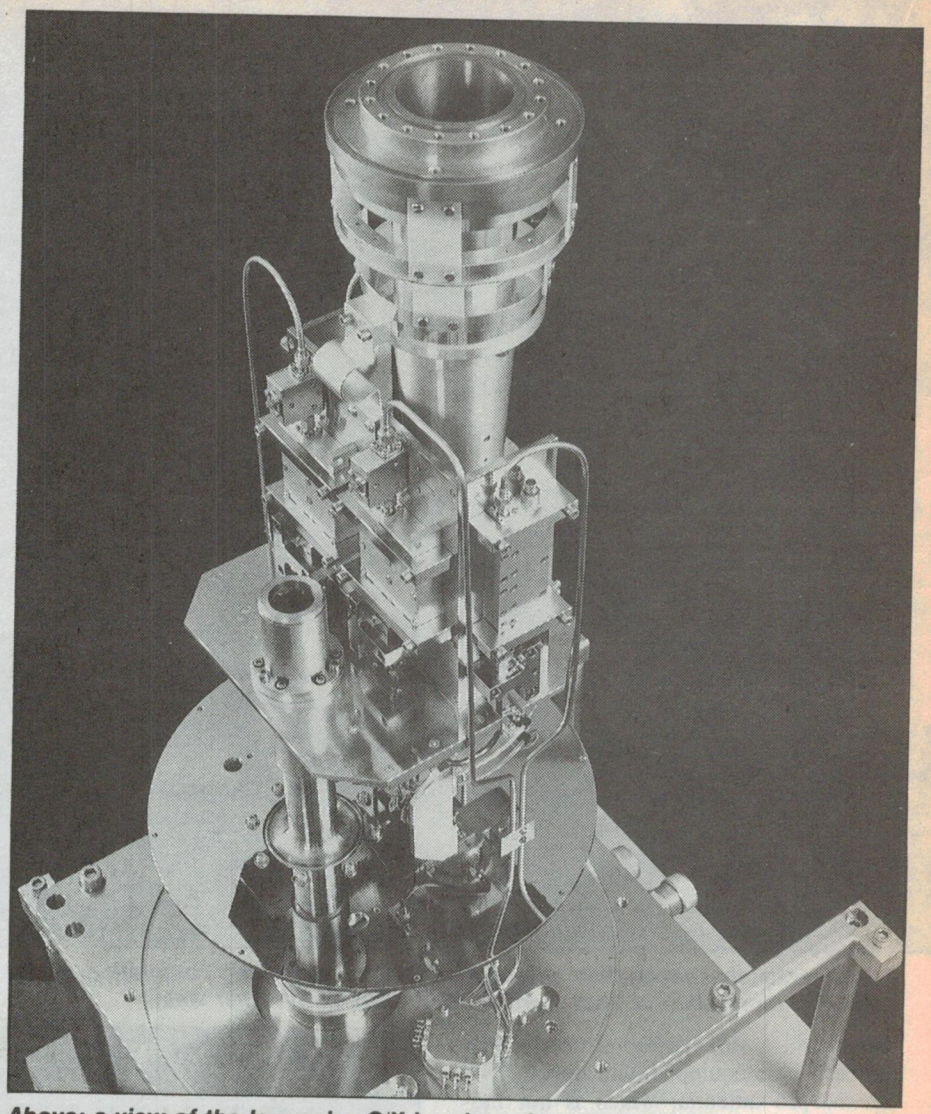
Receiving systems

Special wideband feedhorns, also developed at the Division of Radiophysics, enable simultaneous dual-polarization operation at 20 and 13cm, and at 6 and 3cm. Each horn feeds two pairs of low noise FET amplifiers (one pair for each wavelength band) which are housed in a single Dewar and refrigerated, using helium gas, down to −263°C. The feedhorns and associated amplifiers are set in a rotatable turret, set off-axis near the Cassegrain focus at the centre of the main reflecting surface; an appropriate rotation sets the required system on-axis.

At Culgoora the four outputs per antenna, each of bandwidth 256MHz, will be digitized at 512Mbaud and sent through optical fibres to a control building; use of conventional coaxial cable for this purpose would have degraded the bandwidths. For the more remote antennas the signals will be recorded on special wideband tape recorders and processed after at Culgoora. For a typical observation of four 12-hour periods, the final images will have a low noise level of about 1.5×10^{-28} W m^{-2} Hz^{-1}.

Correlators

The IF signals reaching the control building from the antennas will be processed in large correlators. The correlator is the heart of the entire Australia Telescope operation – it not only has to correlate the signals from pairs of antennas, but also must provide outputs with a wide range of resolution in frequency. These requirements imposed considerable constraints on the initial correlator designs, and a successful design was possible only because a suitable Very Large-Scale-Integration (VLSI) chip was developed by the Division of Radiophysics. The chip, a mere 5mm across, contains nearly 50,000 transistors. Several thousand were fabricated for the project by Austek Microsystems of Adelaide.



Above: a view of the low-noise C/X-band receiver. The wide-band feed horn is at the top. Right: sites used for the Australia Telescope.

Manufactured by the 2.5-micron HMOS process, each chip operates at 16MHz. Correlator boards equipped with 16 chips provide up to 1024 correlator channels, at input rates of 256 megabits per second. More than 300 boards will be needed for five separate correlators – three at Culgoora (one each for CA wideband continuum, CA narrowband spectral-line, and LBA observations) and individual units for Parkes and Mopra to support single-dish operation when these antennas are not required for LBA operation.

The spectral options vary from 18 channels covering 256MHz, to 8192 channels covering 0.5MHz. The smallest channel separation of 60Hz is more than adequate to cope with the frequency structure observed in the narrowest maser spectral lines in the interstellar medium.

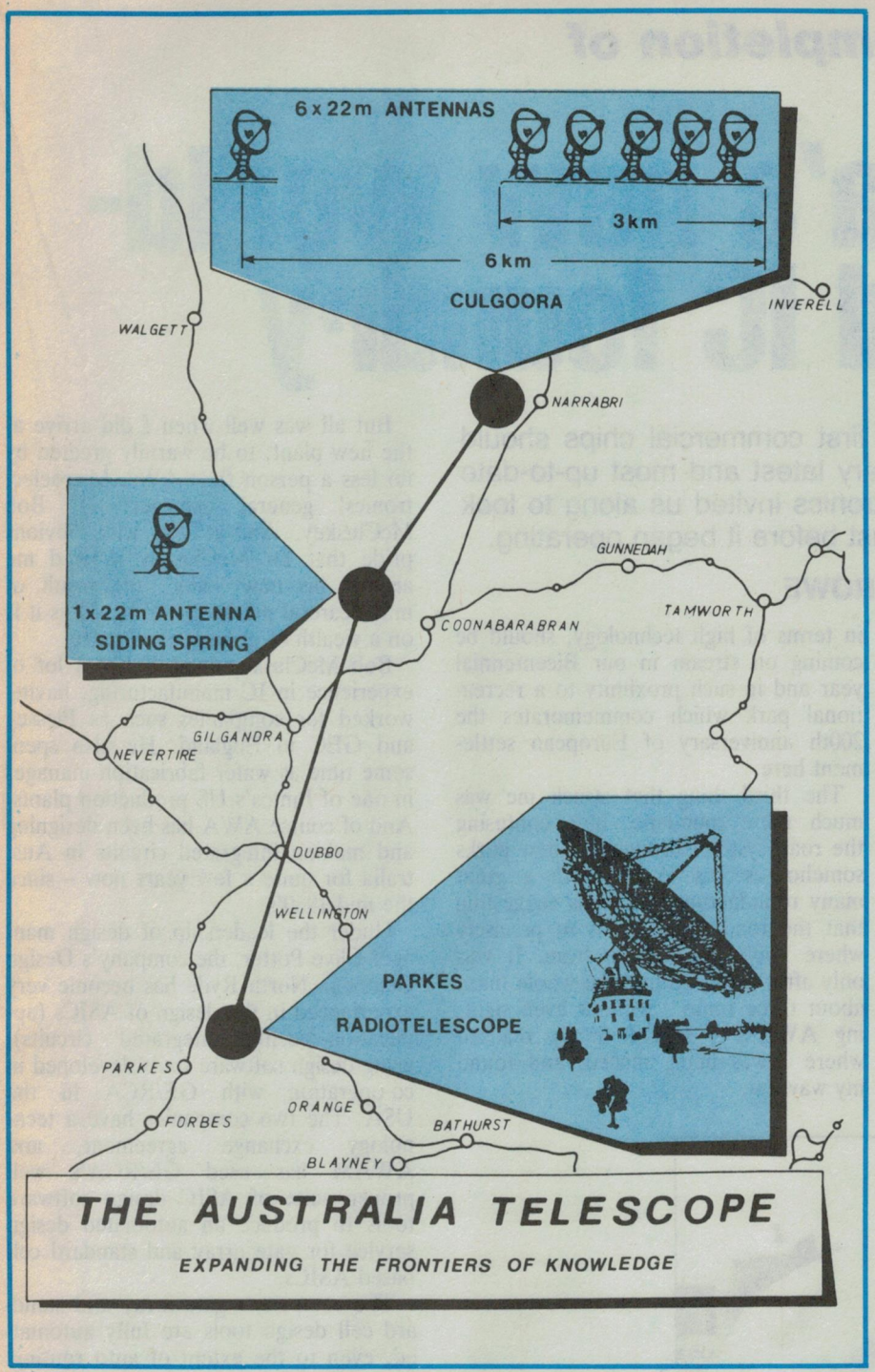
Computer networks

Extensive computer systems are required for the facility. Two VAX 8200 computers are located in the Culgoora control building. One (the "synchronous" computer) is responsible for all tasks synchronised to both the array control and the data sampling as set by the correlators; the other (the "asynchronous" computer) controls the data collection, the preliminary processing, and the data recording on magnetic tape.

An extensive data reduction centre has been developed at the Radiophysics headquarters in Epping, Sydney for production of images and for further image processing activities. The main processor in this network is a CONVEX C-210 mini-supercomputer.

Summary

The Australia Telescope is a fine tribute to Australian expertise – it was con-



ceived, designed and constructed by Australians, with over 80% local content.

With this instrument Australia's radio astronomers face a rosy future; once again they will be able to compete, on equal or better terms, with overseas radio astronomers. Moreover, their instrument will complement the new generation of telescopes (both orbiting and ground-based) operating at other wavelengths.

Most important of all, the Australia Telescope is the only instrument of its type in the southern hemisphere. Northern telescopes, no matter how elaborate, cannot reach much of the southern sky, and miss out on many of the unique objects located there.

It will take some time for the Australia Telescope to reach its full potential. However, there is little doubt that this instrument will play a leading role in radio astronomy for many years to come. EA

Coming next month in Electronics Australia

Multi-purpose preamp module

Here's a preamp module with uses limited only by your imagination. You can wire it up as a mic preamp, as a magnetic cartridge preamp, to boost the output from a tape deck, to provide some special equalisation or filtering, as a mixer input channel module – you name it. It's low cost and easy to build, too!

16-tune doorbell

Tired of hearing the same old "Ding-Dong" when people press your doorbell? Here's an easy to build electronic doorbell circuit which will play your favourite from a selection of 16 familiar tunes – or come up with a different one at random, every time.

Using your PC as a function generator

There's no need to panic if you need a signal with a special waveform – use this simple D-to-A adaptor to turn your personal computer into a programmable function generator. It's much simpler and cheaper than a dedicated instrument...

**Note: although these articles have been prepared for publication, circumstances may change the final content of the issue.*

AWA nearing completion of

Australia's new world-standard IC foundry

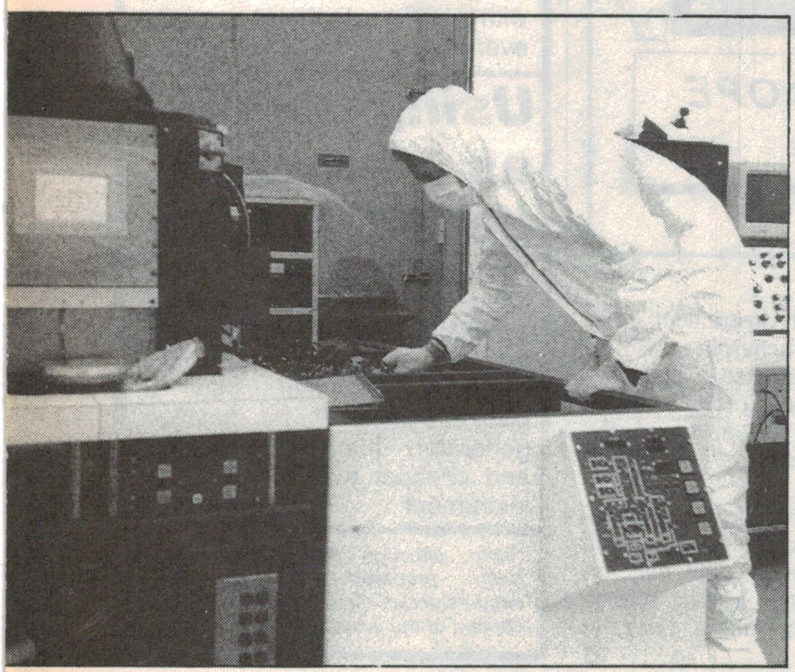
By the time you read this, the first commercial chips should be emerging from Australia's very latest and most up-to-date silicon foundry. AWA Microelectronics invited us along to look over its impressive new plant, just before it began operating.

by JIM ROWE

Three things struck me as I neared AWA Microelectronics' brand-new production plant in the western Sydney suburb of Homebush. One was that the new industrial park in which it's located reminded me a lot of Silicon Valley in California, where silicon chips were first produced. Nicely planned, with plenty of trees and parking lots set back from the road to create a pleasant working environment.

The second thing was that the AWAM plant is literally only a stone's throw from the recently dedicated Australian Bicentennial Park. It seems somehow appropriate that this new world-class silicon foundry, signifying in many ways Australia's 'coming of age' in terms of high technology, should be coming on stream in our Bicentennial year and in such proximity to a recreational park which commemorates the 200th anniversary of European settlement here.

The third thing that struck me was much more mundane: how confusing the road system through the new parks somehow seems to be, with a great many roundabouts and signs suggesting that the road ahead leads to precisely where you've just come from. It was only after going around the whole maze about three times - without even sighting AWAM – that I finally realised where I was being misled, and found my way out.



Assembly and checkout of the Cambridge Instruments EBMF 10.5 electron-beam mask fabricator, capable of writing details down to 0.1 micron.

But all was well when I did arrive at the new plant, to be warmly greeted by no less a person than AWA Microelectronics' general manager, Dr Bob McCluskey. And it was with obvious pride that Dr McCluskey showed me around his new 'baby', the result of much careful planning and based as it is on a wealth of existing experience.

Bob McCluskey himself has a lot of experience in IC manufacturing, having worked for companies such as Plessey and GEC in England. He also spent some time as wafer fabrication manager in one of Inmos's US production plants. And of course AWA has been designing and making integrated circuits in Australia for quite a few years now – since the mid 1960's.

Under the leadership of design manager Clive Potter, the company's Design Centre in North Ryde has become very experienced in the design of ASICs (application-specific integrated circuits), using design software tools developed in co-operation with GE/RCA in the USA. The two companies have a technology exchange agreement, and AWAM has used GE/RCA's well proven suite of ASIC design software tools to produce an automated design service for gate array and standard cell based ASICs.

The company's gate array and standard cell design tools are fully automated, even to the extent of auto routing. They are also capable of coping with very complex architecture, a feature which recently won AWAM an important OTC contract.

The performance of analog circuits and logic cells can be simulated during the design phase with SPICE and RCAP analog circuit simulators, running on AWAM's VAX11/785 computer. Because the simulation software works at the gate level, it is particularly fast and cost effective.

The graphics for chip layout are designed using a Calma GDSII interactive system, which includes design rule

checking and pattern generation software.

Similarly AWAM has been fabricating chips and assembling devices for many years at Rydalmere, a few kilometres away, in a plant originally used for valve manufacture and converted for semiconductor fabrication in 1964. Fabrication technologies covered at the Rydalmere plant include bipolar, metal gate and silicon gate CMOS, NMOS and CMOS-bipolar mixed technology, using 3" diameter wafers and 4 micron design rules (0.5 micron registration). Processes available have included ion implantation, epitaxy, diffusion and plasma etching.

The new Homebush facility is for the first time bringing all of AWA Microelectronics' design, fabrication and assembly operations together under the one roof. At the same time it represents a dramatic upgrading of the company's fabrication technology, making it by far the most modern in Australia - and of current world standard.

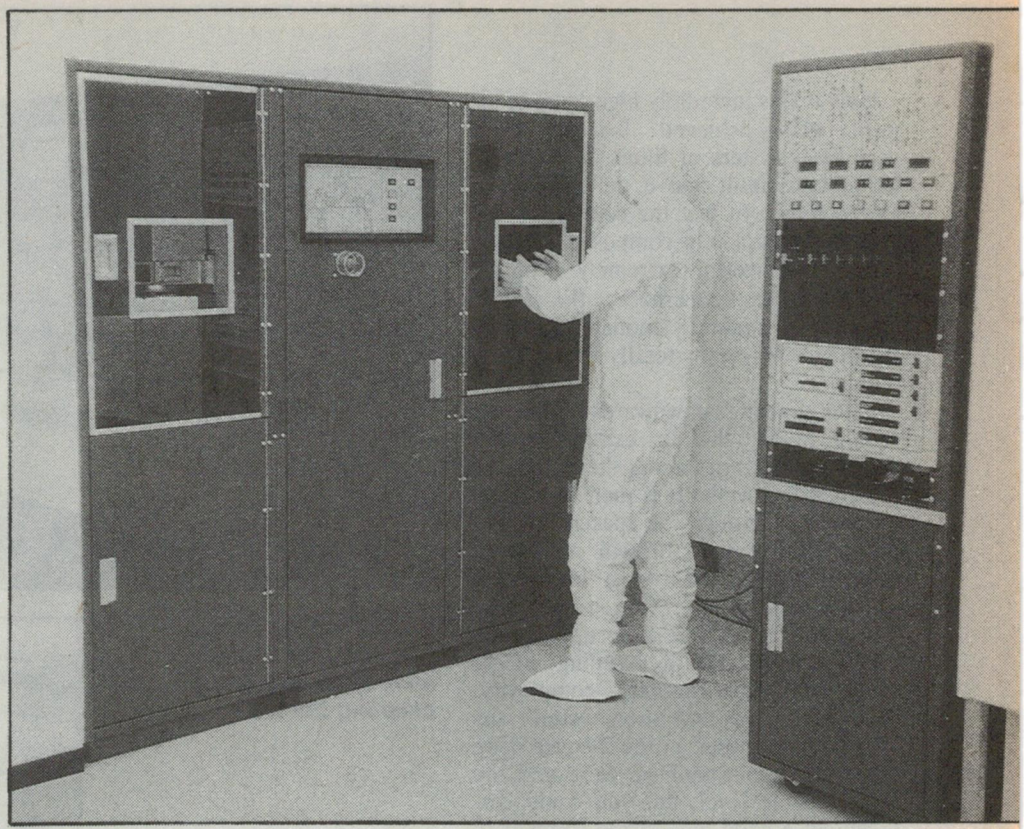
Actually the new production facility is the result of a joint venture formed in 1987 between AWA, British Aerospace Australia and the New South Wales Investment Corporation, with AWA having the controlling interest. The joint venture partners have initially invested some $35 million in the plant, while a further $30 million is to be invested over the next few years.

Initial impressions

Perhaps the thing that impressed me most initially about the new plant, as Bob McCluskey showed me through, was the air conditioning and filtering system. Someone once said that modern semiconductor plants were basically very large, complex and expensive air conditioning/filtering systems, with a small factory hidden deep inside – and that certainly seems true here again.

As the Homebush plant has been designed with sub-micron fabrication in view, its air conditioning and purification system is designed to meet the highest possible standards achieveable with current technology. The specification for the wafer fabrication area called for Class 10 air purity, defined as less than 10 particles of 0.5 micron size per cubic foot of air. The target they were hoping for was even more stringent: less than 10 particles of 0.2 microns.

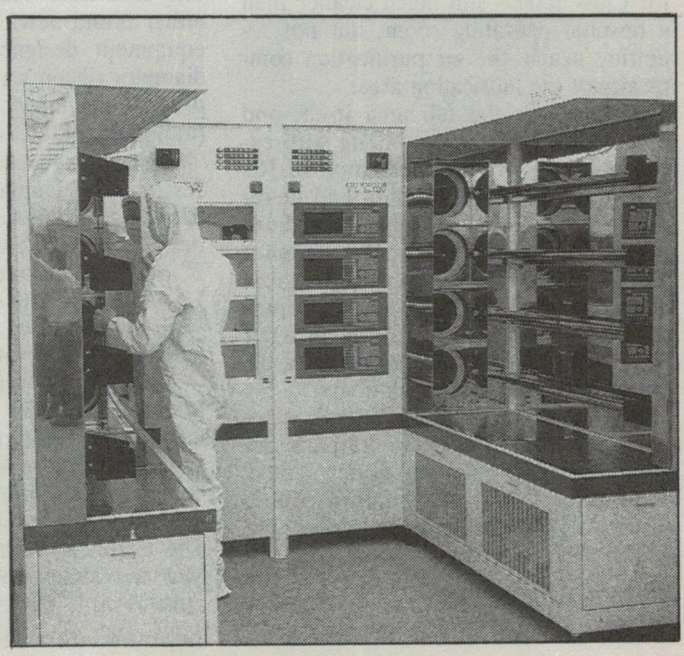
What is the figure they've *actually* achieved? It was the obvious question, of course. With great delight, Bob McCluskey informed me that the initial figures have turned out to be an amazing 1 particle of only 0.1 micron size per cubic foot – almost two orders of magnitude better than the specification!



The operating side of the Eaton 6200 ion implanter, which can operate at current levels up to 2mA (at 200kV) when implanting dopants such as boron into the silicon wafers.

This is particularly impressive when you consider that the size of a typical *virus* particle is around 0.1 micron. The figure above is also only an initial reading, before all equipment was installed in the clean room and normal control procedures could be adopted. The final operating figure would normally be expected to be somewhat better again.

For comparison, the now rather outmoded but still functional Rydalmere fabrication facility has an air purity rating of Class 10,000 – meaning 10,000 particles of 0.5 micron size per cubic foot. Positively grubby, by comparison with Homebush!



Two of the diffusion furnace bays being installed. There are three bays in all, each with four compact cylindrical furnaces.

How is this incredibly high level of air purity being achieved? Basically by a very fancy system of filters and recirculating fans, built above the fabrication area ceilings. In fact the ceilings of this area are completely composed of filter modules, delivering extremely clean air into the rooms concerned at the rate of 90 feet per minute – enough to change the air in the rooms totally every 6 seconds.

After moving downwards from the ceiling filters, the air exits from the rooms via openings along the bottom of the enclosing walls. It is then sucked up by the fans through the spaces between the walls, to pass through pre-filters, cooling coils and back down through the ceiling filters again.

Bob McCluskey took me up into the area above the fab area ceiling, to get an idea of the system's complexity. Most of the fans and filters weren't visible, being enclosed in the 2-metre deep space between where we were and the actual ceiling level, but you could certainly get a good idea of the complexity of the system. I found it very impressive indeed.

Approximate cost of the air conditioning and purification system for the Homebush plant's fab area is around $3 million – extremely pure air doesn't come cheap! The assembly area of the new plant doesn't need to be nearly as critical as the wafer fab area, by the way, because when the wafers reach this area the chips on them are complete and passivated. The specification calls for Class 1000 – still much cleaner than a hospital operating room, but not requiring nearly the air purification complexity of the fabrication area.

But back to the fab area itself, and other points of interest. Along with extremely pure air, the fabrication of ICs also requires incredibly pure and de-ionised water. So the new Homebush plant also has a very fancy Permutit water purification plant, which takes Sydney's ordinary tap water and processes it at the rate of 20 gallons per minute through a complex system of ordinary and reverse osmosis filters.

The final pure and 'polished' water that emerges has less than 0.5 parts per million of total solid impurities, and a resistivity of 18 megohms. In other words, it's not only extremely pure, but an excellent insulator.

Fab equipment

What of the hi-tech semiconductor fabrication equipment that goes inside this ultra-clean fab area? Well, it's all either brand new, or newly refurbished equipment designed to work with 6" diameter silicon wafers, and to an initial process technology level of 1.5 microns (minimum feature size).

The epitaxy reactor is a Cambridge Instruments Unipak X, with a Hugle 35kW RF generator. This was originally designed to work with multiple rows of 2" wafers, but recently rebuilt in the USA to work with 6" wafers.

There are three Tytan diffusion furnace bays, each with four furnace tubes – a total of 12 separate furnaces. The furnaces are new and very compact units, rather shorter than earlier types.

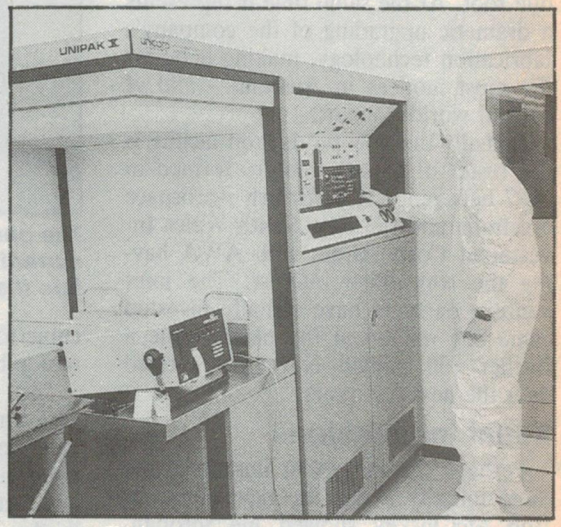
A single Eaton 6200 ion implanter is being installed initially, with a second unit planned for installation in 1990. The Eaton is a 'medium current' unit, with the ability to run ion beam currents of up to 2mA when implanting dopants such as boron. It uses a 200kV power supply.

For printing the wafers with the various etching/implantation patterns, there's an ASM (Advanced Semiconductor Manufacturers) PAS 2500/10 printer, the very latest type with the best specs currently available. Heart of the printer is the 5:1 reduction lens used to image onto the wafers from the masks, which is designed to give a resolution down to 0.8 microns. This kind of precision doesn't come cheaply either – the lens itself has a five-figure price tag.

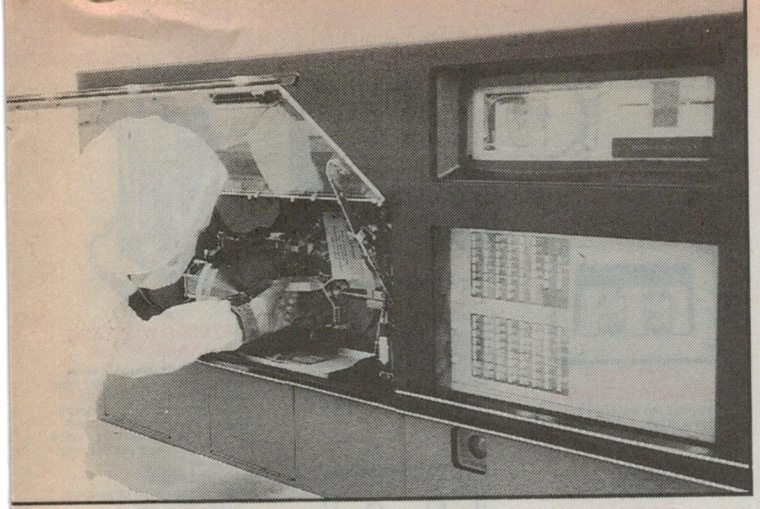
The PAS 2500/10 is also fully computer controlled, with all wafers barcoded so that they are tracked through the various fabrication steps to avoid errors. Since wafers pass back through the printer a number of times (once for each fabrication process), this is quite important.

The AWAM fab facility is designed so that the wafers are coated with photoresist in very close proximity to the printer. This allows them to be printed

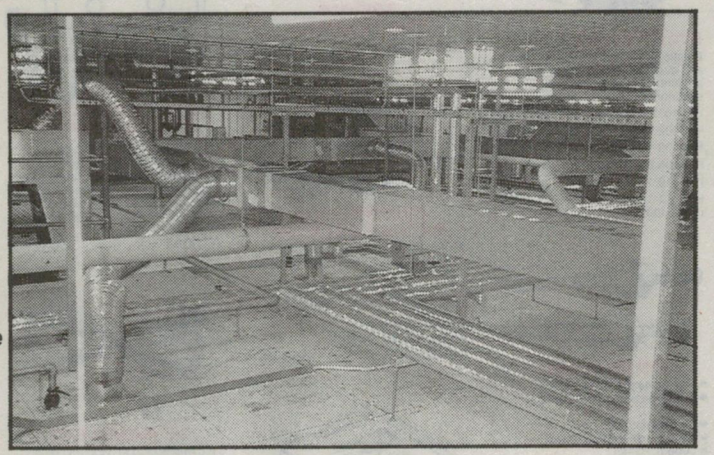
Above: one of the four Ultra Fab Technology semi-automatic wafer cleaning benches.



Right: Setting up the Cambridge Instruments Unipak X epitaxy reactor, which has been modified to take 6-inch wafers.



Left: Operating side of the Varian 3280 metal sputtering unit, used for applying metallisation to the wafers.



Right: A view inside the space between the roof and the fan/filter layer, above the fab area – to give an idea of the facility's air conditioning system.

within 1 hour of coating, to ensure the most controllable results.

The printing masks themselves are made on a Cambridge Instruments EBMF 10.5 (electron beam mask fabricator). This is the very latest type again, and has the ability to write details down to around 0.1 micron. It also has the ability to write directly to wafers, if this is desired in the future or for short runs. Almost as impressive as the performance of the EBMF is its price: over $3 million!

Other items of interest in the fab area include a Varian 3280 metal sputtering unit, for wafer metallisation, and three LAM Research plasma etchers – dedicated respectively for etching metal, oxide and polysilicon. There are also four Ultra Fab Technology semi-automatic wafer cleaning benches.

Overall design of the new fab facility (including the clean room itself) was carried out by AWAM's own engineers, headed by process technology manager Vladimir Svoboda and wafer fab manager Andrew Brawley.

All in all, the new facility is initially well equipped to produce double metal CMOS wafers with feature sizes down to 1.5 microns, at the rate of around 500 of the 6" wafers per week.

One of the three LAM Research plasma etchers used in wafer fabrication. One is used for etching metal, the other two for oxide and polysilicon respectively.

Outside the fab area, wafers will be tested on AWAM's spanking new Trillium "Validmaster" test system. This cost a cool $2 million, and has two testing heads capable of checking out device performance at a rate of 60MHz. One head will be used for wafer testing and the other for final testing of packaged devices.

From testing they will move into the assembly area, to be sliced into chips and mounted into packages. Wafers will be sawn into chips on a Disco precision wafer saw, and the chips bonded into packages using either three new Kulicke and Soffa 1419 autobonders or a Mech-El unit (for ceramic packages).

The K & S bonders each have the ability to handle 600 chips per hour, while the Mech-El can handle 500 per hour. So the total bonding capacity will be around 2300 chips per hour.

In the case of most of AWAM's products, which are likely to be relatively low-volume ASIC devices, the final package is likely to be of the metal/ceramic type. However the company is also installing a Kras plastic moulding press, and will therefore be able to offer lower-cost plastic packages in the common 14, 16 and 18-leaded DIL formats, as well as the larger 68- and 84-pin PLCC (plastic leadless chip carrier) formats. But the emphasis will still be on small to medium runs. For runs of greater than 10,000 pieces they will generally arrange for assembly and packaging to be done overseas at larger plants (typically Singapore).

This underlines AWAM's overall strategy in planning the new Homebush facility, which has been to produce a world class, state of the art ASIC design and manufacturing centre geared to the needs of the Australian electronics industry. The idea is to concentrate on specialised market areas such as communications, defence and services – the same areas which offer the best opportunities for local equipment makers.

As AWAM's marketing manager Toby Cross stressed, "We're not in the business of making jellybean devices. But for designing and making ASICs and things like proofing of new designs, we can now offer facilities equal to those you'll find anywhere."

When I went through the new plant, installation of its production gear was well advanced. The first runs of commercial silicon should be emerging about the time you read this story, all going well.

What is planned for the existing Rydalmere production facility? Toby Cross explained that this will be run in parallel with the new Homebush facility, until the latter is fully operational and achieving its potential. Then it will be phased down, with existing product lines transferred to Homebush. Current estimates are that this will take place early next year.

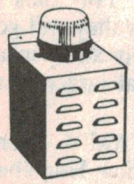
Of course all of the existing North Ryde design centre facilities will be transferred to Homebush, as soon as the fabrication plant is operational. The existing VAX11/785 computer will be augmented with a MicroVAX II ma-

continued on page 141

PASSIVE INFRA-RED DETECTOR
(WP-800)

FEATURES:
- Walk test LED indicator
- Wall/corner/ceiling mount
- Micro switch tamper proof protection
- 24 detection beams in 3 different ranges
- N.C. silent S.P.S.T. dry relay contact output
- Alarm auto reset approximately 3 seconds after triggered
- Superior RFI immunity protection
- Extremely low power consumption
- Adjustable mounting bracket
- Easy installation, easy adjustment
- Dual element, low noise, high signal to noise ratio pyroelectric
- Detection degree indicator
- D.C. 8-16V power operating

S15079 ..... **$89.95**



EXTERNAL SIREN & FLASHING LIGHT

Housed in a waterproof, metal case, with tamper switch.

SPECIFICATIONS:
Siren:
DC 12V. 450 mA
Impedance 8 ohm
S.P.L. (dB/W) 110
Dimensions: 135 x 150mm
Flashing Light:
DC 12V
100 flashes per minute
Dimensions: 82 x 100mm

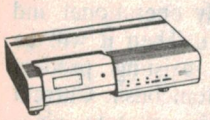
..... **$89.50**

BIG MOUTH CAR ALARM

FEATURES.....
- Easy installation
- Automatic on/off
- Loud alarm signal
- Auto reset
- Low Price!

SPECIFICATIONS:
Power: DC 12V battery
Current Consumption: 10mA at 12V DC
Dimensions: 139 x 165 x 136mm
Exit Delay: 60 seconds approx.
Entry Delay: 12 seconds approx.
Auto reset: 90 Seconds approx.

S15048 ..... **$39.95**



P.I.R. SENTRY

FEATURES:
- 7 LED indicators
- Passive Infra-red detection radium
- Built-in piezo siren
- Rechargeable 12V battery
- Built-in automatic battery charging system
- External siren connections
- Exit/Entry system
- Terminals for external detection devices
- Separate digital panel and main unit
- 3 Function switch: delay/off/instant
- 3 Adjustable timers
- 24 Hour loop included
- Built-in tamper switch
- Adjustable detection angle
- LED monitor for walk test
- R.F. Protection design

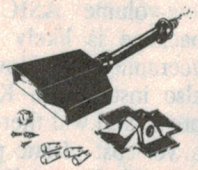
S **$175**

10W HORN SPEAKERS

White durable plastic, 8 ohms

Cat. C12010 **Normally $11.95**

1-9 **$7.95** 10+ **$6.95**



PIR FLOODLIGHT

A perfect all night security device with dual element Passive Infra Red sensor. All weather outdoor operation. Features off, automatic, test and manual on at your wall switch. Complete with wall mounting bracket, cable terminations and instructions.

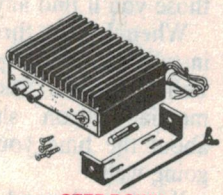
SPECIFICATIONS:
Detecting range: minimum 6 to 15 metres with variable control.
Detecting zones: 5 at 15° short, 12 at 8° medium, 12 at long range
Preset time: From 1 to 20 minutes with manual overide.
Photocell sensitivity: Activates circuit at about 2 footcandles, off at about 8 footcandles of light.
Positioning Adjustment: 2 ball joints allow free adjustment to suit area.
Relay output: Up to 500W of incandescent load only.
Power: 240V AC 50Hz

A15597 ..... **$185**

MINIATURE HOBBY VICE

- Lever operated suction grip base for instant mounting and portability
- Mounts on smooth non-porous surfaces.
- Ideal for holding components, and other small/light objects.

Cat.T12458 ... **only $6.45**



STEP DOWN CONVERTER DC-DC

Built around a heavy duty heatsink this unit features the latest transistor switching technology to convert 24V DC to 13·8V DC. Finished in matt black with a unique mounting bracket makes it the best in its class.

SPECIFICATIONS:
Input Voltage: 24V DC
Output Voltage: 13·8V DC
Primary Current: 4·2A (24V input 4A output)
Output Current: 4 Amp continuous rated (5·5A max.)
Size: 125(W) x 50(H) x 90(D)mm
Weight: 450 grams

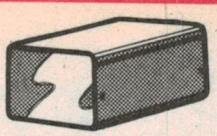
A16155 ..... **$99.95**

10A STEP DOWN CONVERTER DC-DC

Built around a heavy duty heatsink this unit features the latest transistor switching technology to convert 24V DC to 13·8V DC. Finished in matt black.

SPECIFICATIONS:
Input Voltage: 24V DC
Output Voltage: 13·8V DC
Primary Current: 11A (24V input, 10A output)
Output Current: 8 Amp continuous rated (12A max.)
Size: 125(W) x 50(H) x 175(D)mm
Weight: 900 grams

A16160 ..... **$119.95**



HORWOOD ALUMINIUM CASES

H10382 3 x 4 x 2 inches	$ 5.50
H10383 3 x 4 x 3 inches	$ 6.50
H10384 3 x 4 x 4 inches	$ 7.50
H10385 3 x 4 x 5 inches	$ 7.95
H10386 3 x 4 x 6 inches	$ 8.50
H10387 3 x 4 x 7 inches	$ 9.50
H10388 3 x 4 x 8 inches	$10.50
H10389 3 x 4 x 9 inches	$10.95
H10390 3 x 4 x 10 inches	$11.95

UTILITY BOXES

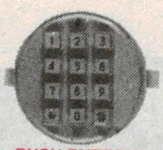
Plastic boxes with aluminium tops, and availabie in four sizes. Very popular for projects and very economical!

H10101 150x90x50mm	$ 3.25
H10102 195x113x60mm	$ 4.50
H10103 130x68x41mm	$ 2.75
H10105 83x54x28mm	$ 1.95
H10110 120x65x38mm	$ 2.95
H10112 120x65x38mm (Metal top)	$ 2.95

PIN SWITCHES

- Self tapping and adjustable
- Suitable for car doors, hoods, trunks
- Single lead hook up
- Easy to use, easy to install
- Length: 45mm

S12522 ..... **$3.95 pair**



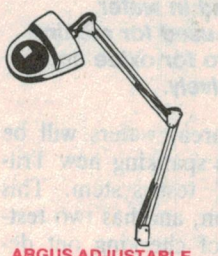
PUSH BUTTON DIALLERS

Tired of old fashion dialling and re-dialling engaged numbers? These convenient push button diallers include last number redial (up to 16 digits) and instructions for an easy changeover.

Cat. A12030 ..... **Normally $19.95**

SPECIAL, ONLY $14.95

(Note: Not Telecom approved)



ARGUS ADJUSTABLE MAGNIFIER WITH LAMP

Perfect for close up work! Intricate PCB's, projects, etc., will be a breeze under this superb, adjustable magnifying lamp.
- Magnifies 1.75 times
- 40 watt incandescent lamp
- 2 external spring-balanced arms, extendable to 800mm
- Adjustable head for optimum viewing angle.
- Variety of mounting bases available but not included.

Cat.T10015 ..... **Only $99**

CLAMP BASE

To suit above Argus Lamp

T10016 ..... **$9·50**

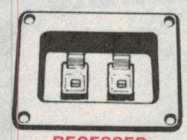
T-BASE

To suit above Argus Lamp

T10017 ..... **$17·50**

42mm PIEZO BUZZER

S15073 ..... **$7.95**



RECESSED SPEAKER TERMINAL

Push button. red and black terminals

Cat.P10248 ..... **$1.95**

TRIGGER TRANSFORMERS

Cat. M10104 ..... **$1.45**

SUPER DELUXE BATTERY CHARGER

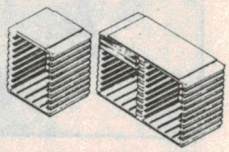
- Charges from 1 to 10 D, C, AA, AAA, N, and up to 3 x 9V batteries at the same time.
- Dual colour LED in first three compartments to designate 1·5V or 9V.
- 240V AC/50Hz.
- Approval No. N10637

Cat.M23525 ..... **$59.95**

POCKET SIZE BATTERY TESTER

- Tests all 9V to 1·5V batteries including button cells.
- Arms extend to various battery sizes
- Easy to read meter.
- Requires no power source.

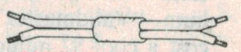
M23521 ..... **$11.95**



COMPACT DISC STORAGE UNITS

- Holds 10/20 compact discs in their cases
- Interlocking modular design allows vertical and horizontal interlocking
- Discs slide into place horizontally making titles easy to read.
- Wall mount or free standing.

A10031 (10 discs) **$12.95**
A10032 (20 discs) **$19.95**



CAR BATTERY ISOLATOR

Designed for car burglar alarm back-up battery. Allows the back-up battery to be charged from the car battery and isolates the back-up battery by not allowing the back-up battery to drain back to the car battery.

A12095 ..... **$3.20**

JOINABLE PCB MOUNTING SCREW TERMINALS (GREY)

	1-9	10+
2 Way Cat. P10520	**$0.50**	**$0.45**
3 Way Cat. P10521	**$0.75**	**$0.65**

3½" EXTERNAL DRIVE

- 720K formatted capacity.
- 37 way D type connector fits directly onto drive controller card.
- Compatible with IBM* PC/XT.
- Requires DOS 3·2 or greater.
- Size: 266(D) x 104(W) x 75(H)mm

..... **only $395**

CD TO CAR CASSETTE STEREO ADAPTOR

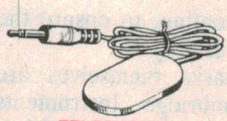
Enables a portable CD player or portable TV to be played through any car speaker system by using the cars cassette player. Reduces the risk of theft. Just plug in when required, and remove when you are finished. Hard wiring not needed.

A10011 ..... **$29.95**

IEC MAINS LEAD

3 pin mains plug to 3 pin IEC plug. 1·8 metres long.

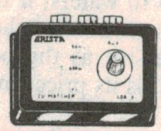
P10252 ..... **$5.95**



TELEPHONE INDUCTION COIL

- For recording or amplification
- 3·5mm plug with 1 metre cord
- Peel-off stick-on adhesive back

A12032 ..... **$5.95**



CD PLAYER ADAPTOR

Many amplifiers have only one auxiliary input. This makes using a compact disk player as well as another auxiliary input inconvenient. Also the majority of CD players have an output voltage of 1·6 or 2 volts whereas the auxiliary input norm is 750mV. This CD adaptor allows dual auxiliary input, and one input has variable gain setting.

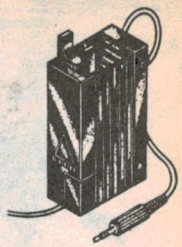
SPECIFICATIONS:
- Input 2 sets of 2 x RCA sockets
- Gain 150, 300, 600mV, 1V and 2V
- Output 2 x RCA sockets

A11510 ..... **$23.95**

SPOTLIGHT 12V

Quartz halogen spotlight. Hand held with moulded plastic grip. Brilliant beam up to 55W, can be seen for miles. Orange lens cover, emergency flasher switch, 3 metre curled cord, cigarette lighter plug and replaceable H3 halogen bulb.

Cat. A15050 ..... **$26.95**

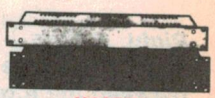


STEREO WIRELESS TRANSMITTER

This unit was developed to allow portable compact disc players to be used in cars by transmitting the headphone output signal directly in to your stereo FM car radio. It will also transmit any mono/stereo signal from any headphone output to any FM receiver.

SPECIFICATIONS:
- Input 3·5mm stereo phone plug. Impedance 32 ohm.
- Mono/stereo switch has plug mounting clip.
- FM Transmission approx. 90-35MHz (Tuneable 89-91MHz)
- Range 15 metres. (below 15mV/m at 100 metres)
- Power 1·5V AAA size batteries (100 hours continuous use)
- Size 72 x 38 x 21mm

A16100 ..... **$69.95**

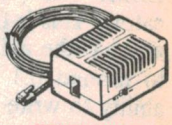


MASTER RACK MOUNTING CABINETS

These superb rack mount cabinets will give your projects a real professional appearance! Just look at these features...
- All dimensions conform to the International Standard
- All aluminium construction
- Choice of black or natural finish
- Deluxe brush finish anodised front panel
- Removeable top and bottom lid
- Ventilated lid

Horizontal Depth: 254mm
A = External Front Panel Height mm
B = Mounting Hole Centres mm
C = Internal Chassis Height mm

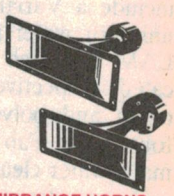
A	B	C	Finish	Cat.No.	Price
44	34	38	Natural	H10401	$59.50
88	57	82	Natural	H10402	$69.50
132	89	126	Natural	H10403	$79.50
44	34	38	Black	H1041	$65.00
88	57	82	Black	H10412	$75.00
132	89	126	Black	H10413	$85.00



TELEPHONE EXTENSION BELL

- 10 metre length extension cord.
- Features US type plug
- Use with US/Australian adaptor

Y16043 ..... **$25.95**



MIDRANGE HORNS

Use these quality, all metal, Piezo tweeters for great top end sound in your band speakers, disco sound system, etc. Rated at 30 watts RMS, in a system they will handle over 100 watts RMS.

Two sizes to choose from:

Size: 4"x 10½"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 1·5kHz - 14 kHz
Dimensions: 102 x 267 x 177mm

Cat. C92082 **Normally $49.95**
This month only $39.95

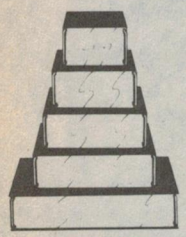
Size: 3"x 7"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 2kHz - 15 kHz
Dimensions: 76 x 177 x 145mm

Cat. C92084 **Normally $29.95**
This month only $24.95

Dealers, OEM's, etc., phone (03) 543 2166 for wholesale prices

008 335757 TOLL FREE MAILORDER HOTLINE FOR CREDIT CARD ORDERS! LOCAL ORDERS & INQUIRIES CALL (03) 543 7877

EVERYTHING YOU NEED!



HORWOOD METAL INSTRUMENT CASES (ROUND HANDLES)

84/6/V
H10461 153 x 102 x 203mm **$18.95**
84/8/V
H10462 203 x 102 x 203mm **$19.50**
84/10/V
H10463 254 x 102 x 203mm **$19.95**
84/12/V
H10464 305 x 102 x 203mm **$22.95**

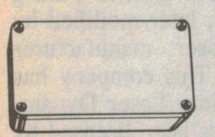
HORWOOD METAL INSTRUMENT CASES (SQUARE HANDLES)

93/6/V
H10467 153 x 76 x 228mm **$16.95**
93/8/V
H10465 203 x 76 x 228mm **$17.95**
93/10/V
H10466 254 x 76 x 228mm **$18.95**
93/12/V
H10468 305 x 76 x 228mm **$21.50**
93/17/V
H10470 430 x 76 x 228mm **$29.95**

SUPER HORN TWEETER

- Requires no crossover and handles up to 100W!
- Sensitivity: 100dB/0.5m
- Frequency Response: 3kHz-30kHz
- Impedance: 8 OHMS
- Size 96mm diameter

Cat. C12102 ..... **Normally $12.95**
SPECIAL, ONLY $9.95



DIECAST BOXES

Diecast boxes are excellent for RF shielding, and strength. Screws are provided with each box.

H11451 100 x 50 x 25mm .. $ 5.95
H11452 110 x 60 x 30mm .. $ 6.50
H11453 120 x 65 x 40mm .. $ 6.95
H11461 120 x 94 x 53mm .. $11.50
H11462 188 x 120 x 78mm ... $13.50
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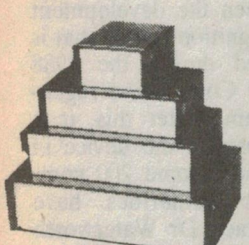

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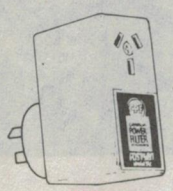

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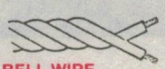

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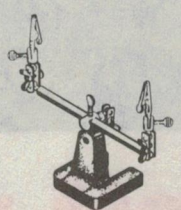

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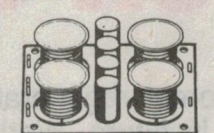

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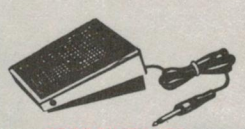

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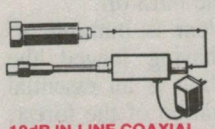

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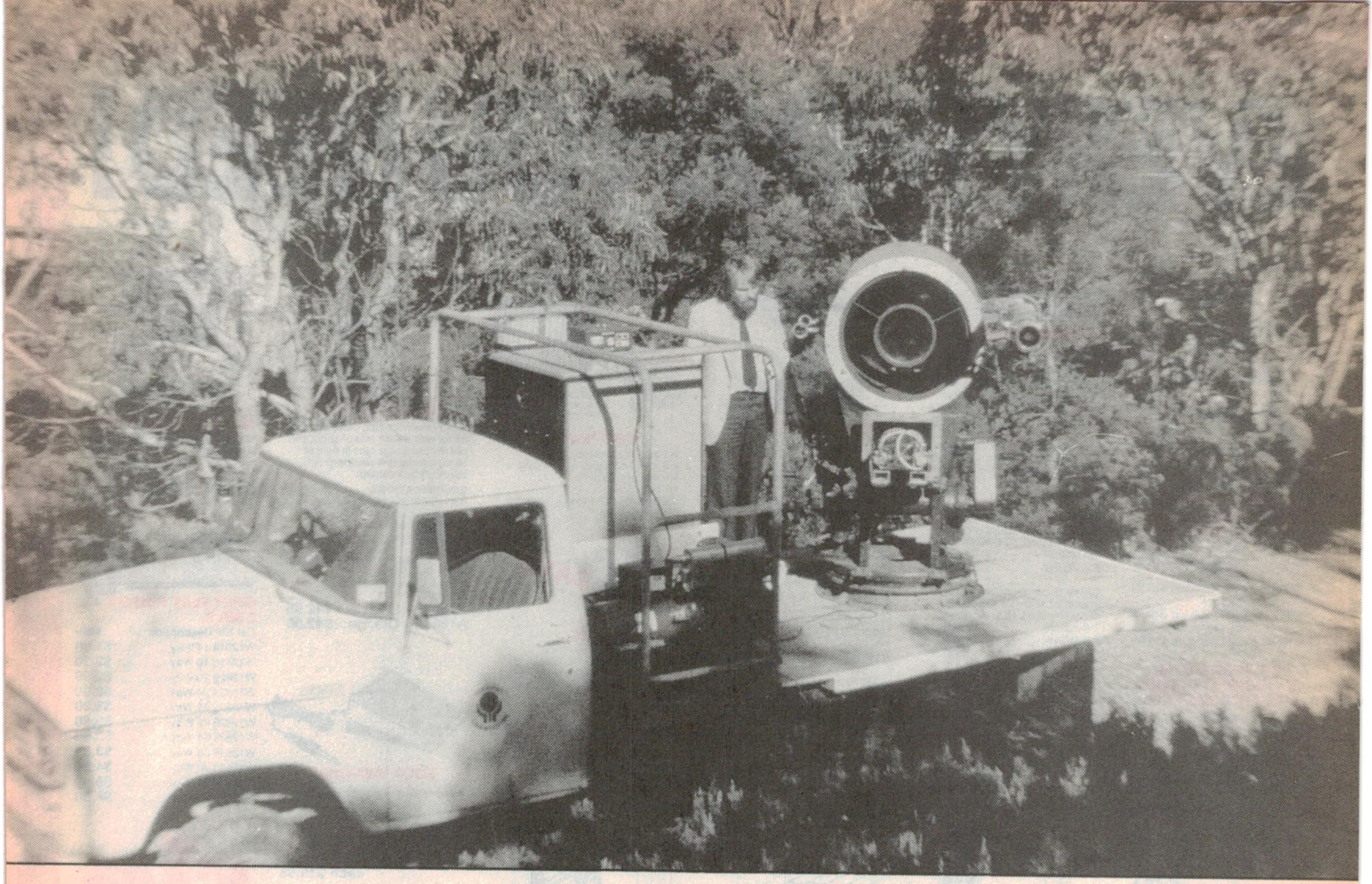


Burning off with a laser

Environmentalists take heart! Forest regeneration is likely to be enhanced with laser beams in future. World wide interest is currently being shown in Lucifer – an Australian development involving the use of a high-power laser beam as an accurate means of igniting forest waste.

by PETER PHILLIPS

Laser beams have long been associated with the more exotic tasks of brain surgery, holograms, homing beams for nuclear weapons and so on. Using a laser beam to burn off rubbish might seem the height of over-kill, but the advantages are many, particularly if you are the one controlling the burn off.

A particular problem is burning off forest slash after having logged the area. Burning the slash is an essential ingredient to regeneration of the forest, and is a task fraught with dangers for those involved. Traditional methods include ignition with manheld drip torches, electric igniters or "incendiary matches" dropped from aircraft.

Apart from the obvious dangers to personnel, the likelihood of igniting more than was intended is very high, and various fire disasters have occurred over the years as a consequence. For these reasons, the Tasmanian Forestry Commission approached the Physics Department of the University of Tasmania some 10 years ago, with the idea of using a laser beam to light the fires. Although the initial response was "Don't be silly!", it took Dr Michael Waterworth, a Reader in Physics at the university, approximately two weeks to reconsider – and to get the university involved in what was to become an extensive project.

Dr Waterworth originally built a prototype device called "Lucifer", using a 200 watt CO_2 laser, later modified by the Gold Coast laser manufacturer Radiation Research. This company has now been reformed into Laser Dynamics Ltd (LDL) and has been licensed by the University of Tasmania to develop and market Lucifer. To this end, Dr Waterworth has been involved in the project with LDL engineering director John Kavanagh for the last nine years.

The result has been the development of a 750 watt laser ignition device that is to be demonstrated during the 1988 Tasmanian Forestry Commission regenerative burn program. After this, it is proposed to demonstrate the device in North America, where some 200 companies and public authorities have shown interest. In fact, Dr Waterworth has conducted extensive research in North America, and also with various forestry authorities throughout Australia.

The LDL version of Lucifer employs

a 750 watt carbon dioxide fast axial flow laser, a beam expander, range finder and a joystick controlled Cassegrain auto-focussing telescope. The laser beam is first beam expanded, then accurately focussed onto the required point. Collectively, this arrangement can produce a high intensity hot spot of the appropriate size and energy density at the required distance.

Focussing is achieved by adjustment of the beam expanding optics, and the whole device is fully steerable in the horizontal and vertical planes. The laser material is a combination of carbon dioxide, helium and nitrogen. It is claimed that ignition occurs within 2 seconds of application of the hot spot, with the capability of pinpoint accuracy at distances from 10 to 1500 metres with a spot size no more than a few centimetres.

The diagram of Fig.1 shows a block diagram of the system, which is represented essentially by three modules; the laser, the focussing optics and the projection telescope.

The fact that no other country in the world has succeeded in the development of a similar device is testimony to the difficulties involved in such a project. The main problems that had to be overcome were the need for a continuous output from the laser, (up to several hours at a time), the sophisticated optics required, and the need for auto focussing.

The optics problem was an issue somewhat familiar to the Waterworth family, as the company called E.N. Waterworth, (at one time Waterworth – Bessel) had been operating for over 60 years, under the supervision of Dr Michael Waterworth's father. With this type of expertise available "in the family", the solving of the optics problem was possible, with Mr Waterworth senior being able to put into practice the ideas from his son.

Interestingly, it was because of these and other problems that similar research being conducted in the USA was abandoned.

Once operational, however, considerable research was needed in how to make this "hi-tech blow lamp" portable, and then over the terrain typical of a forest.

As shown in the accompanying photo, the device is mounted on the back of a table top truck, on a vibration free base. Considerable effort was required to solve the dichotomy of stump-jumping and laser technology, and much research was needed to make the laser system suitably rugged.

The energy source is also mounted on the truck, behind the cabin, adding up to a total weight of around one tonne. Transportation by ship or helicopter is also possible, allowing it to be used almost anywhere.

One problem, typical of all current high-power lasers is the amount of input power required. For the 750W device here, some 14kVA of input power is required. This means that approximately 13kW of heat must be dissipated, implying the need for an efficient cooling system.

The power supply for Lucifer operates at 18kV, and making such a power source portable was a problem in itself. Because the laser beam may be on for up to several hours at a time, the problems of cooling and power source portability are somewhat enlarged.

Apart from setting fire to scrub, there are many other envisaged uses for Lucifer, as the ability to precisely locate a point of ignition has many advantages. Other applications include precision ignition of oil spills, controlled burning of sugar cane and grain stubble, tree trimming near power lines, avalanche control, breaking of pack ice at sea, deicing of runways and so on.

An airborne version is planned for early 1989, which will allow the burning of fire breaks in normally inaccessible forest. To enable the device to be used from a helicopter, the system will incorporate gymbal mountings for stability of the beam. This way, precise targetting will still be possible while the 'copter is bumping around in the usual fashion.

Other more esoteric uses include cleaning buildings, paint removal, deicing TV towers, and various defence applications. Star Wars on a more friendly basis, but hi-tech nonetheless, and another world first for Australian science and technology.

Our thanks to Dr. Michael Waterworth for his assistance in the development of this article. EA

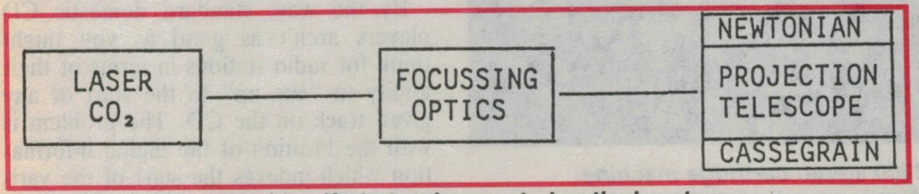


Fig.1: Block diagram of Lucifer's truck-mounted optical system.

Award-winning Australian development:

Keeping the phase within the cart

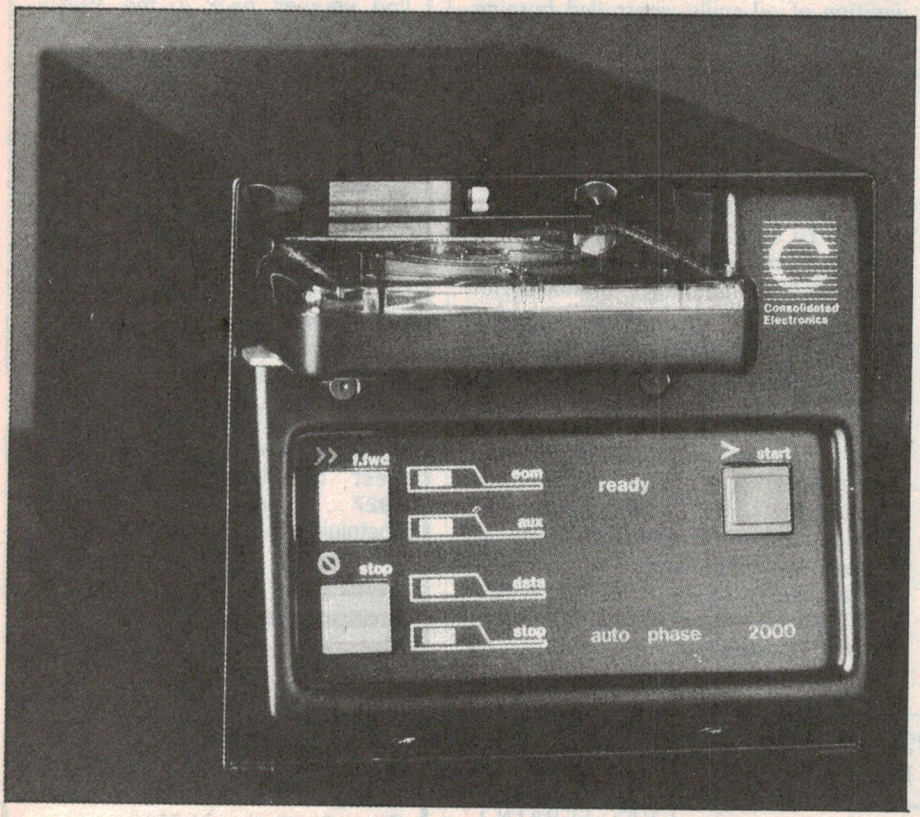
Melbourne-based Cunningham Consolidated's Autophase 2000 professional stereo tape cartridge machine has won a prestigious award for design innovation, and is meeting with warm acceptance among radio broadcasters both here and overseas. Here's a look at the operation of stereo cart machines, and how the Autophase 2000 solves a previously worrying problem.

by LANCE MILNE Chief Engineer, 3EON-FM Melbourne

The Autophase 2000 is a good example of the way we Aussies can show the world the way to go in high-tech industries, if we have the backing. Designed primarily for radio broadcasting, this new stereo cartridge machine incorporates features which won its developer and manufacturer Cunningham Consolidated an Industrial Design Award.

The machine has also won wide acceptance among radio stations, both here in Australia and overseas. In the last 12 months over 300 have been sold, including 135 to Singapore and 50 to Europe.

To understand what is so clever about the design of the Autophase 2000, we need to take a look at what a cartridge tape machine does and how radio stations use them.



Developed in Australia, the Autophase 2000 stereo cartridge machine achieves a significant improvement in stereo reproduction.

Nearly all radio stations use cartridge (cart) machines fairly heavily. Cartridges themselves are a continuous loop tape, wound on a central hub and enclosed in a two-piece plastic body, very much like the old 8-track cartridge tapes that were all the go in cars some years back.

The main differences are firstly that broadcasting carts run at 19cm/sec (7.5 ips), which is four times the speed of a compact audio cassette and twice as fast as the old 8-track carts. Secondly broadcast carts have a special cut-out hole in the front, for the pinch roller of the deck to come through, whereas the old 8-track variety had the pinch roller built in to the body of the cart – which is a less accurate system.

Both have standard-width 6.3mm specially lubricated tape wound into them, so the continuous loop can roll freely. The diagram of Fig.1 shows how the tape rolls from the outside to the inside of the layers of tape, then out and past the heads from left to right, and then back onto the outside of the spool again. A bit of thought will show you that each layer must slide on its neighbouring layer.

Most commercial stations are reliant on carts to play commercials, jingles and music tracks. There is a fairly obvious advantage in handling rugged cartridges within a studio, which are easily stored and located and just need to be "plugged in" to a cart player, rather than fiddling around with and cueing up tapes, records and compact discs.

By the way, standard domestic CD players aren't as good as you might think for radio stations in terms of their ability to "cue up" to the start of any given track on the CD. The problem is with the location of the digital information which indexes the start of the various tracks on a CD. Index points are

Prime Minister Bob Hawke with Cunningham Consolidated's MD Peter Roberts, at the design award presentation.

"spot on" the start of audio on some discs, but on others there is one second or more gap between the index mark and the actual start of the audio. Many discs even vary the gap on individual tracks of the same CD!

Some stations have overcome this problem by modifications to the players so that they cue to the index first and then search for audio and wait in the PAUSE mode for the announcer to fire them up. The very latest professional CD players actually have this facility built in.

But back to carts. As mentioned before, cartridges are convenient in a radio station because the operator doesn't have to cue them up to the start of the audio. Obviously this means that there is an automatic cueing system built into the design of the cartridge system, so let's take a look at the format used to record the signals onto the tape.

The track standards for broadcast carts were laid down by the NAB (National Association of Broadcasters) in the USA over 20 years ago. Originally, there were 2 tracks, the top one being for the audio and the bottom one for the "cue-tones" (which we'll get back to in a minute). Of course, an extra track is needed for stereo audio, so the current standard is 3 tracks, of equal width and equal spacing across the tape.

By looking at the diagrams (Figs 2 and 3), you will notice that unfortunately, this means that stereo-format carts are not compatible with mono ones – which has caused its fair share of troubles within stations as they convert to stereo! The left channel audio goes at the top, right channel in the middle and the cuetones at the bottom.

Fig.2: The standard track format used for mono cartridges.

Fig.3: The standard track format used for stereo cartridges, for comparison.

You have probably already guessed that the *cuetones*, or tones on the cue track, control the starting and stopping of the cart. Top marks! There are actually 4 cuetones that go on that bottom track, all with quite separate functions.

The primary cuetones is a burst (usually about one second long) of 1kHz sinewave which is recorded simultaneously with the commencement of audio. This actually marks the "end" of the tape, because it is a continuous loop.

When the cart is in a playback deck and has played the audio, the transport stops when it detects the 1kHz tone – so the cart is cued ready for its next play. The transport is stopped by pulling the pinch roller away from the capstan shaft, usually by releasing a solenoid or driving a reversing motor.

The second cuetone is again a sinewave, this time at 150Hz. It is referred to as the end-of-message pulse or EOM tone, and has three functions, concerned with marking the end of audio rather than the end of the tape.

To explain in more practical terms, suppose I wanted to record a piece of music that runs for 3 minutes 48 seconds. Generally, instead of winding tape into a cartridge body that runs for exactly that time, I would pick the nearest "stock" time longer than required, say 4 minutes. The only complication is that this particular music doesn't abruptly stop at 3:48 but starts a slow fade out at 3:42 and is gone by 3:48. How would I describe the finishing point? No problem. The leading edge of the pulse (in other words when the tone commences) marks the "beginning of the end" of the recorded audio (at 3:42) and the "trailing edge" of the tone marks the finish of audio (at 3:48), even though the cart will still be in motion until 4:00. Therefore the 150Hz tone will have 6 seconds duration.

The idea behind all this is that on playback, the leading edge of the EOM pulses will activate a detector in the cart player that will signify to the external world that audio is starting to fade out. This could flash a lamp on an announcer's console, but more often will automatically start another cart machine (or some other source) playing in a studio or automation system, to achieve a nice cross-fade between items. As long as the tone remains (in our example 6 seconds) then the output of the cart machine remains active. At the trailing edge of the tone, the audio output of the player switches off (to avoid tape noise and any other clicks or pops appearing) and the machine will jump into the fast-forward mode, if it is so equipped. This is generally 3 times normal speed, and will naturally raise the frequency of the stop tone to 3kHz. So the EOM pulse is a useful auxiliary tone.

The third cuetone is actually a narrow-band FSK (frequency shift keyed) tone centered on 3.5kHz and modulated

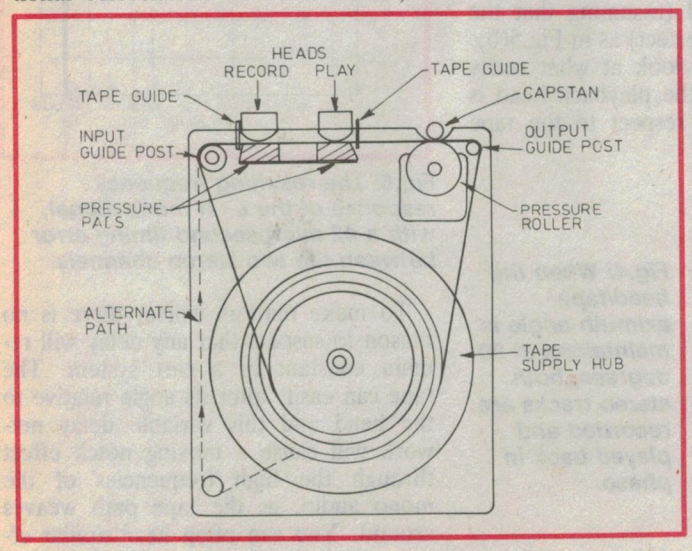


Fig.1: The general layout of a 1/4" endless tape cartridge as used by broadcasting stations, showing where the heads, capstan and pressure roller meet the tape.

by a data stream at 300 baud that can be used for just about anything. Typically it represents details of the cartridge recording, which can be fed to logging equipment – to tell the station's accounting computer how many times a particular client's commercial was played, in order to send them the bill! This data stream can naturally be recorded at any time on the tape, but is usually started a few seconds after the audio to make sure it fits in neatly with the other cuetones.

The last cuetone is at 8kHz and is another auxiliary marker tone that can be used as the station requires. As you can see, the cuetones and the 3-track format of carts make for a very functional system within a radio or TV station.

The system, however, like any other is subject to certain problems and limitations. Since the widespread use of stereo broadcasting, one difficulty in particular has raised its ugly head. The problem is that carts themselves have quite a variation in their ability to accurately maintain the timing between the two audio channels. To understand this, have a look at Fig.4.

Ideally, the recording head should be at an exact right angle to the direction of the tape, so that the maximum amount of magnetic flux variations (corresponding to the recorded audio) can squeeze onto the tape for any given speed (this sets the maximum fequency that can be recorded). This means that any audio information that is common to both left and right channels will be in line with each other, because they have been recorded by the gaps on the recording head which are on top of each other, in line at right angles to the tape direction.

Hopefully this hould also be the case with the playback head, but unfortunately variations in the tape path caused by things like moulding variations between cart bodies, erratic head pads and badly adjusted tape guides tend to put the tape out of line (azimuth) with the playback head. This causes a time difference between channels of the recovered audio, with some nasty side effects, particularly for broadcasting. The worst of these is commonly referred to as "phasing".

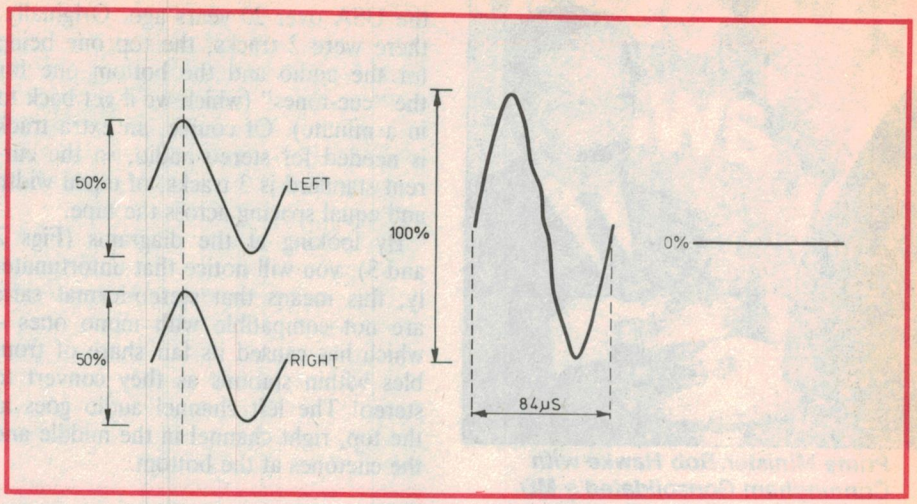


Fig.5: The effects of phasing errors on the L+R mono component. In (a) we see original 12kHz L and R signals, in phase; in (b), the resultant L+R when they remain in phase; in (c) the L+R signal with one channel delayed by only 42 microseconds.

Phasing is partial or complete treble cancellation in the mono sound (mono being the sum of the left and right channels, or L+R) because the two signals do not arrive to be added simultaneously. Let's look at Fig.5(a) and suppose there are two 12kHz signals that were originally recorded in phase on the cart recorder (in other words there was a 12kHz tone in mono or common to both channels). This would be recorded at 50% amplitude in each channel or 6dB down, so that when the channels are recombined the two signals would algebraically add to form the original 100% 12kHz signal (assuming that the tape transfer was perfect) as in Fig.5(b).

Now let's take a look at what really happens. Suppose the playback head is tilted slightly with respect to the tape (out of azimuth) so that the left channel information arrives slightly before the right channel, as in Fig.5(c). In this case, we'll rig the figures and say that the left channel leads the right by an amazingly small 42us, which corresponds to only 0.008mm or 0.0003 thousands of an inch azimuth error at cartridge speed (190mm/sec).

Now 42 microseconds also happens to correspond to 180° (one half-cycle) at 12kHz. This means that the mono signal (L+R) will be cancelled at 12kHz and be reduced significantly at frequencies right down to 6kHz or so. Sounds bad! Fig.6 shows the resulting frequency response, as the signals would be received on a mono receiver.

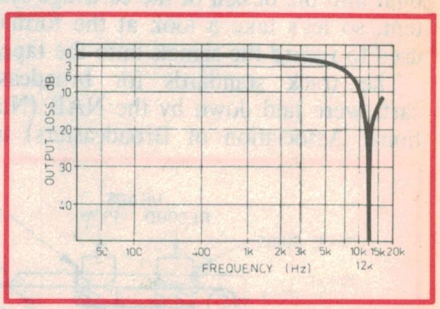


Fig.6: The resulting frequency response of the L+R mono signal, with a 42 microsecond timing error between the two stereo channels.

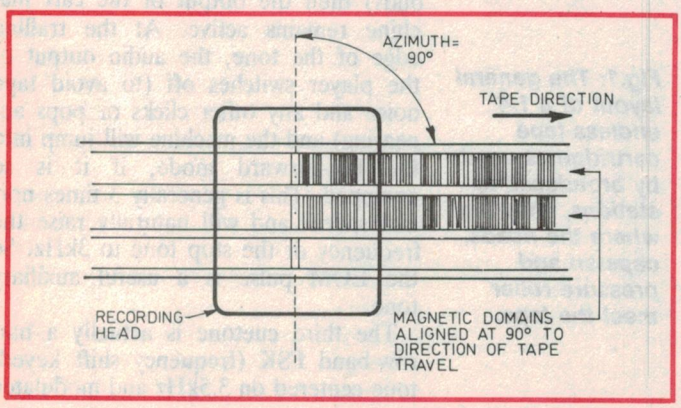


Fig.4: When the head/tape azimuth angle is maintained at 90 degrees, both stereo tracks are recorded and played back in phase.

To make matters worse, there is no reason to suspect that any delay will remain constant in a cart system. The tape can easily alter its angle relative to the head and this variable delay network will cause a moving notch effect through the high frequencies of the mono audio, as the tape path weaves around. You can often hear similar ef-

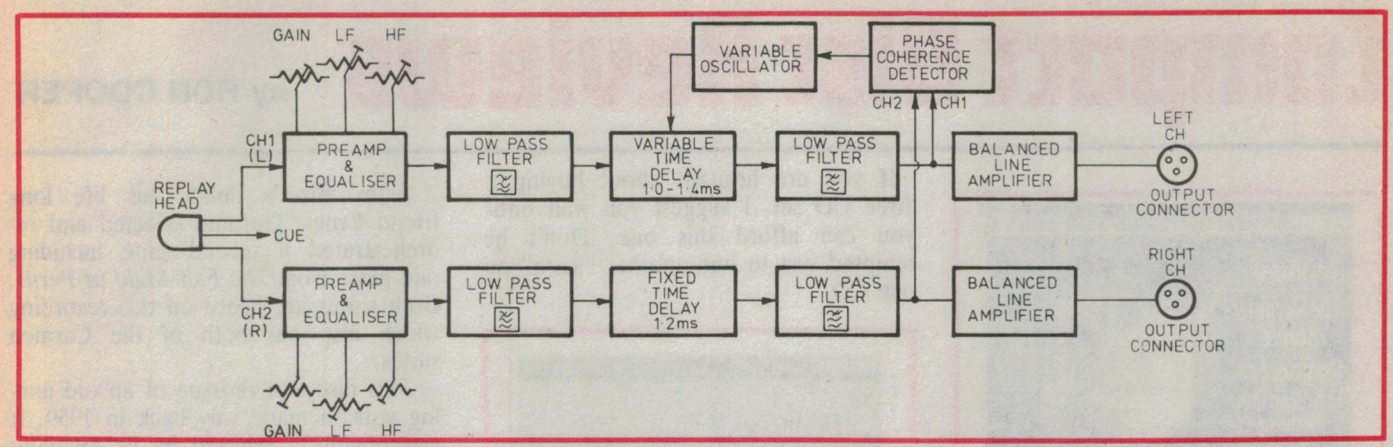


Fig.7: Block diagram of the replay section of the Autophase 2000, showing the phase detector and BBD variable time delay element.

fects when stereo cassettes are played on cheap and nasty mono players.

There are ways to get around these problems, though. One solution is known as matrix format recording. Mono (L+R) is recorded on one track of the tape and the difference (L-R) on the other track. The stereo information is then recovered on playback by dematrixing back to discrete L and R channels. The phasing problem in mono disappears because it now has its own track (rather than the sum of 2 tracks) – but now the azimuth variations result in varing stereo *separation*. Another problem is that matrix format is not much use if you already have an extensive stereo cart library... it's incompatible and it's too late to change now! However, matrix format recording is used by a number of stations very successfully.

Another possible solution is to use an encoded tone on each channel, so the playback machine can watch the delay between the channels and electronically adjust variable networks accordingly. This system also works well but again suffers incompatibility with normal stereo carts.

Wouldn't it be better to have some kind of processor that would automatically monitor the replayed audio and somehow figure out if it was getting too "phasey" and correct it? That's basically what the boys at Cunningham-Consolidated have in fact developed, and incorporated into the new "Auto-phase 2000" replay machines.

A glance at Fig.7 shows the basic layout of the audio section of the machine in simplified block form. The real heart (or should I say brains?) of the circuit is the phase coherence detector, which we'll look at after a quick overall run through.

The individual L and R signals from the playback head are first pre-amplified and equalised to the machine's internal reference level. Next step is a low-pass filter to remove any fequencies that could cause aliasing (heterodyne-fold over) products in the following stage, which is a fast analog sampling device with a multi-stage bucket brigade-type delay line. The left channel has a fixed 1.2ms delay due to a fixed oscillator clocking the samples through the bucket brigade.

The right channel follows much the same path, except that in this case the oscillator frequency can be varied to form a variable time dealy through its bucket brigade from 1 to 1.4ms. This means that the circuitry has a variation range of + or − 200 microseconds between channels. The outputs of the time delay networks then feed to low-pass filters to remove the out-of-band sampling hash (sidebands around the clock frequency and harmonics) and then to the line output amplifiers.

Now to the brains of the circuit, the automatic phase coherence detector. This device is covered by patent applications and its actual workings are still fairly secret. It takes a sample of each channel and analyses the phase choherence over the whole audio spectrum to about 8kHz, with more weighting on the mid to high frequencies. The output of this device is a DC voltage which varies the frequency of the VCO, thus altering the time delay in the right channel and bringing the two channels back in step again.

Thus the whole design is a servo mechanism, with the phase detector monitoring its own corrective action. A great deal of patient research work has gone into getting the loop response (timing of cause and effect) optimised, otherwise the circuit would "chase its own tail" on one hand, or be too slow and therefore audibly ineffective on the other.

Another interesting fact about this design is that all the filters, delay networks, oscillators and phase coherence detector are physically in a set of three hybrid ICs, made in Melbourne by Hybrid Electronics to Cunningham-Consolidated's specifications. The bucket brigades are actually a DIP package chip from the USA within two of the hybrid chips. Good effort!

The obvious question is: How well does it work... is it any good?

Firstly, the machine itself is a neat package with a nice simple functional front panel, heavy duty chassis and transport including a high-performance pinch roller solenoid and Australian-made DC servo motor, with a hub integrated flywheel. The electronics are all on extendable, removable PC boards with a good switched-mode power supply that doesn't blow up!

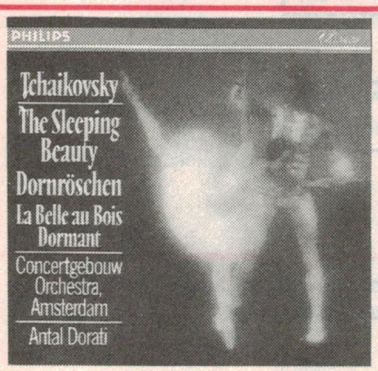
All rear panel audio, power, data and control connectors are good quality and well labelled. The audio performance is basically limited by the tape quality, with low noise, distortion and wow and flutter, and high-headroom low-impedence balanced line outputs. I think it's very good. I have purposely recorded all kinds of music and speech in and out of azimuth and on carts of varying stability, and the machine copes well. Occasionally it has been fooled, where there has been high-energy treble predominately in one channel, (especially from CD) but this is a rare occasion and really only obvious from A-B comparisons to the original.

Its real purpose of correcting timing errors of audio from cart is coped with very well, and it's a very clever way of noticeably improving high-quality stereo broadcasting (AM, FM or TV) for the listening audience.

And it's fully Australian! EA

Compact Disc Reviews

by RON COOPER



TCHAIKOVSKY

The Sleeping Beauty
Dornroschen
La Belle au Bois
Dormant
Concertgebouw
Orchestra
Amesterdam
Antal Dorati
Classics Disc 1 (420 793-2)
Playing time: 3 Disc set 2 hrs 41 min

PERFORMANCE 1 2 3 4 5 6 7 8 9 10

SOUND QUALITY 1 2 3 4 5 6 7 8 9 10

The English conductor/composer Constant Lambert once wrote: *'The Sleeping Beauty* is not only one of Tchaikovskys' best works but an unmistakable masterpiece, both musically and theatrically, in which the composer creates a world of timeless beauty that can be compared to the world created by Mozart in such an opera as *The Magic Flute*.'

I think this sums it up pretty well. Certainly the original scenario presented to Tchaikovsky at the time by Vsevolozhsky and Petipa had very good potential, but in craftmanship alone Tchaikovsky overshadows them. Like the *Nutcracker* and *Swan Lake* the melodies seem to stretch like a golden chain from one end to the other.

The performance and sound of this complete set is excellent in all respects in spite of it being an older analog recording. It has atmosphere and excellent sound balance. The bass is very open and creates the "feel" of the bass drum when played on speakers able to realise this potential.

If you are hesitant about buying a three CD set, I suggest you wait until you can afford this one. Don't be tempted just to buy another "suite" on one CD.

BIZET

Suites, "Carmen" Nos. 1 & 2
"L'Arlesienne" Nos. 1 & 2
Orchestre des Concerts Lamoureux
Igor Markevitch
Silver Line Classics
Playing time: 59 min 32 sec

PERFORMANCE 1 2 3 4 5 6 7 8 9 10

SOUND QUALITY 1 2 3 4 5 6 7 8 9 10

Here is perhaps the most famous of classical music ever written – an evergreen if ever there was one! *Carmen* is naturally Bizet's masterpiece and the pinnacle of French Opera Comique.

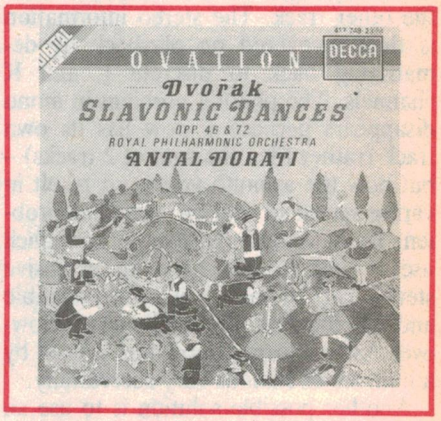
He commenced writing it around 1873 and the premiere was in March 1875. It was a great pity that it was poorly received at the time, which depressed Bizet and he died exactly 3 months after the first performance on June 3rd 1875. The international success of Carmen was strictly a posthumours affair so far as its composer was concerned.

The music for *L'Arlesienne* was written for Daudets' play in just a few weeks in 1872 and was first heard on the 1st of October that year. It is delightful music, has instant appeal and will probably be familiar to most. After the production of the play Bizet arranged five of the orchestral pieces as a suite, increasing the size of the orchestra to symphonic proportions.

After Bizet's death, his life long friend Ernest Guiraud selected and re-orchestrated a second suite including one piece from *The Fair Maid of Perth*. Both suites are heard on this recording which also has both of the Carmen suites.

This disc is a re-issue of an old analog version made way back in 1959. It was obviously selected by its excellent performance of these works and not its sound quality, which is even more dated than some other 1959 recordings but on CD at $19 it is still reasonable value.

However, so far, I am not aware of any other CD releases of these wonderful works.



DVORAK

Slavonic dances
Royal Philharmonic Orchestra
Antal Dorati
Decca 417 749-2
Playing time: 70 min 15 sec

PERFORMANCE 1 2 3 4 5 6 7 8 9 10

SOUND QUALITY 1 2 3 4 5 6 7 8 9 10

Strangely,it was not until Dvorak was 37 that he achieved a breakthrough in his career as a composer. Although studying at the Prague Organ School equipped him as a church musician, he really was self taught by playing viola in the Provisional Theatre and studying scores as far as symphonic orchestrator was concerned.

The two sets of Slavonic dances here were written in 1878 and 1886 and represent two different periods in his life.

continued on page 141

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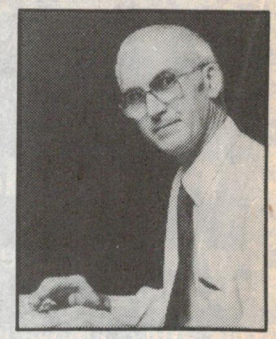
Conducted by Jim Rowe



Oxygen-free copper: more than just marketing hype?

Increasingly, makers of hifi amplifiers and other equipment are claiming the use of "oxygen-free copper" as a feature of their products. Some amplifiers even use this kind of copper wire for internal wiring. It sounds impressive as a selling feature, but exactly what does it achieve apart from that?

This is actually the second time I'm having to type in this month's column – by sheer bad luck, both the hard disk and floppy disk backup copies of my original file were destroyed by water and soot in our fire. Luckily I had made a "hard copy" of about half of it on paper, which was safely stowed in my bag. So at least I've had that to remind me of what I wrote the first time!

Anyway, here we go again, and I hope it doesn't read too much like a rehash:

Some months ago, when I was reviewing an advance sample of one of the new DAT recorders, I noted with some bemusement that the manufacturer placed emphasis on the fact that oxygen-free copper or "OFC" was used in various parts of the equipment. This included the winding wire inside the power transformers, some of the internal wiring – and even the metal pillars on the underside of the case, if I remember correctly.

It all sounded suitably plausible, yet I was a bit dubious.

Like many of our readers, no doubt, I'd noticed the recent appearance of OFC among the selling features for hifi and other gear – especially that made in Japan. The term "oxygen-free copper" was obviously meant to imply that the *ordinary* copper used in other equipment had significant oxygen content, and that this somehow resulted in inferior performance – both electrically, and perhaps mechanically. So that be using OFC, you presumably got a better result.

Somehow the image we were all being invited to imagine seemed to be of ordinary copper as being riddled with little bubbles of trapped oxygen, a bit like a Swiss cheese. And presumably the more trapped bubbles of oxygen there were, the less of your genuine solid copper metal there would be to provide good electrical conduction and mechanical strength. By using solid copper that was free of those pesky trapped bubbles, you'd obviously be avoiding these troubles.

Mind you, none of this was actually explained in so many words. In fact there was very little overt explanation at all. The use of OFC was simply listed as one of the features, seeming to imply that its benefits were self-evident – or perhaps alternatively, in the hope that we'd draw the above naive inferences.

Now I'm certainly not a metallurgist, but it all sounded a bit glib. I guess I was mildly skeptical – and I'm sure I wasn't the only one.

At the time, I wasn't sufficiently concerned about the matter to pursue it further with the experts. As I suggested in the review concerned, the *benefits* of using OFC might well be open to some conjecture, but at least there didn't seem to be any *disadvantages*. At least judging from the performance of the DAT recorder concerned, which was very impressive.

Since then, though, I've received a fairly long letter from a reader – picking up on the subject and exploring it in depth. And as the reader concerned is quite knowledgeable in this area – he's a chartered engineer and metallurgist, in fact – I thought it might be a good change of topic this month to pass on his comments and explore the topic of OFC further.

The reader concerned is Mr Dick Burns, who for a long time was technical manager of the Copper and Brass Information Centre in Sydney. The Centre itself is no longer operating, but it gave advice to the local electrical and electronics industries for many years, as well as providing information links with overseas bodies concerned with copper sourcing, refining and supply. So Mr Burns should certainly know his copper.

Now I'm going to have to boil down the content of his letter, because he does go into the subject in detail and at considerable length. But as I understand it, the story seems to be as follows.

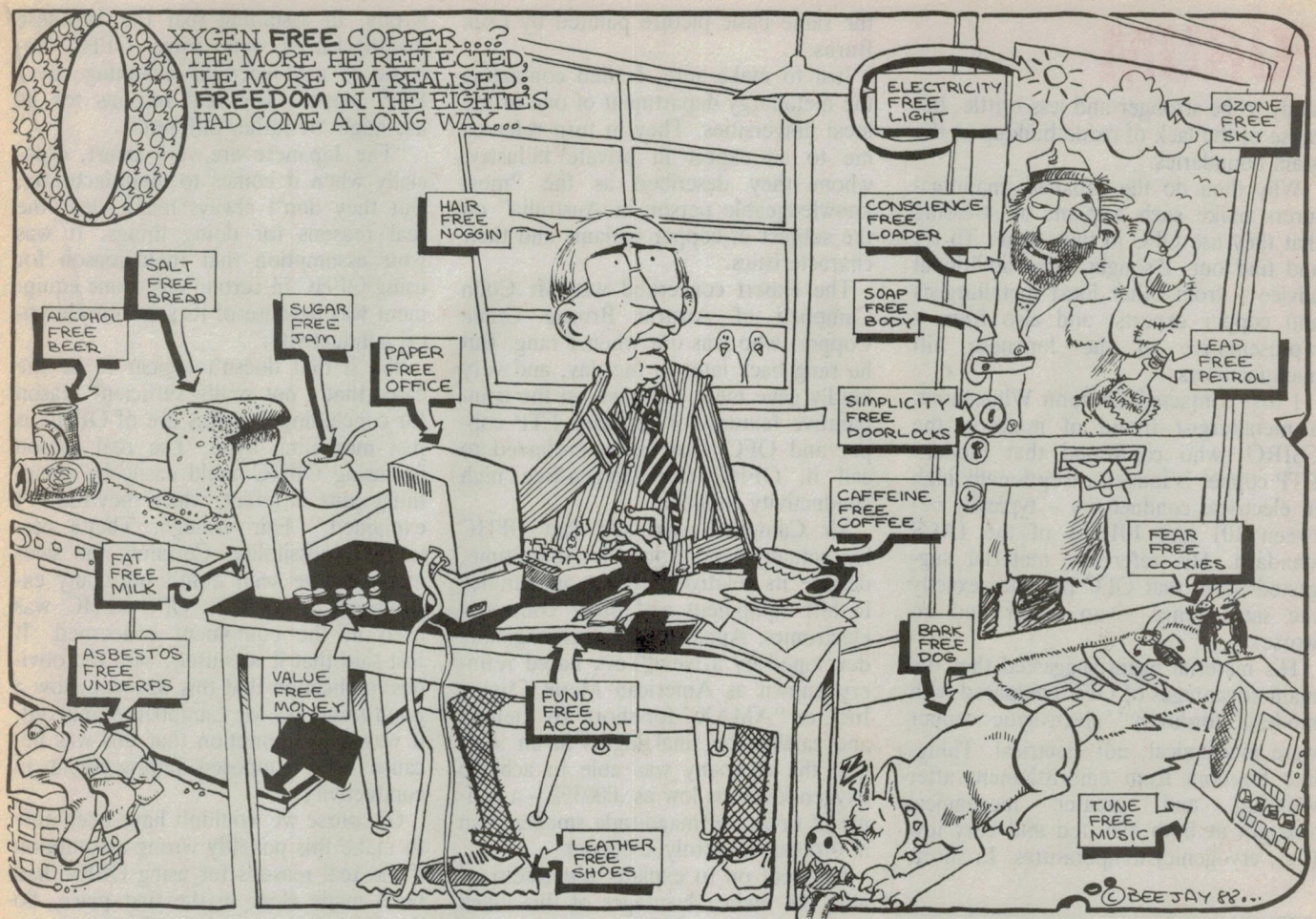
Basically, four standard grades or varieties of copper are recognised for electrical/electronic use by our own SAA and similar standards bodies around the world. As defined by the SAA in its Specification 1279-1985, these are summarised as shown in Table 1.

As you can see, despite their somewhat oddball names (which are apparently related to the refining methods used to produce them), they all have remarkably similar electrical characteristics. Each has a rated copper content of 99.9% or better, while all four have virtually the same *maximum* resistivity of 0.15328 ohms per metre at 20°C.

Similarly in each case their *minimum* conductivity relative to the International Annealed Copper Standard or "IACS" is specified at 100% – presumably meaning that they're all equal to or better than the best grade of electrical copper available when the IACS standard was prepared.

Dick Burns notes that most present-day coppers exceed the IACS standard, due to the fact that refining techniques have improved since it was prepared. Typical modern coppers (like those made in our own refineries at Mount Isa) have a conductivity figure of up to 101.5% of the IACS standard – not all that far below the theoretical maximum figure, which he says is 102.5%. Not bad considering that some 7 million tonnes of refined copper are produced world wide each year!

By the way, the "A" suffix in the type number for the first three copper listed in Table 1 means that they are



made in Australia, while the rest of the number relates them to the appropriate international specifications.

Apparently oxygen-free copper isn't specified in the SAA specification, and according to Dick Burns this is because it isn't made in Australia. Apparently it requires a special refining process, with the copper surrounded by a vacuum or protective inert gas environment during the final "freezing" into solid copper.

To compare OFC with the coppers shown in Table 1, it is therefore necessary to use data prepared by the Conseil International Pour Le Development Du Cuivre (CIDEC), based in Geneva. And when you do this, according to Dick Burns, it turns out that OFC has virtually the same conductivity range as the type 110A copper shown in Table 1 – from 100% to 101.5% of the IACS standard.

In other words, there doesn't seem to be any signifianct difference between OFC and say "ordinary" Aussie-made 110A *Electrolytic Tough Pitch* or "ETP" copper, in terms of electrical conductivity at least.

How much oxygen?

But just how much oxygen is there in ordinary copper, and what else might it do? Well, Dick Burns says that modern ETP copper has an oxygen content of .05% maximum. Most of this is apparently concentrated at the boundaries of the copper grains, in the form of copper oxides.

According to Mr Burns the main effect of this is to produce a tendency for the copper to become brittle, especially in environments where it will be subjected to high temperatures and/or where reducing gasses will be present. I gather this tends to make OFC preferable to ETP copper for things like lead-in wires for high power thermionic valves, rotor windings for high power motors and alternators, and so on.

So far then, it begins to look as if the main advantages of OFC are mechanical rather than electrical. It looks as if it's

TABLE 1: STANDARD TYPES OF COPPER

Code	Name	Copper content min. (%)	Electrical Resistivity (ohms/m) at 20 C	Conductivity % of IACS minimum
110A	Electrolytic Tough Pitch	99.90	0.15328	100
110A	Fire Refined High Conduct.	99.90	0.15328	100
116A	Silver bearing tough Pitch	99.90	0.15328	100
119D	Phosphorised High Conduct.	99.93	0.15328	100

A table supplied by Mr Burns, comparing four main types of copper. As you can see, there are few differences.

FORUM

likely to be stronger and less brittle, because of the lack of oxide buildup at the grain boundaries.

Why then do the Japanese manufacturers make such a point of stressing that they use OFC in their gear? To try and find out, I sought some additional advice – from other local metallurgists and copper experts, and also from a representative of the Japanese hifi manufacturers.

I first contacted Dr John Wilmshurst, a metallurgist friend of mine in the CSIRO, who confirmed that modern ETP copper is indeed exceptionally high in electrical conductivity – typically between 101 and 101.5% of the IACS standard. His reference material suggested again that OFC provides exactly the same range – no better and no worse.

His material again suggested that the main advantages of OFC compared with modern "ordinary" electrolytic copper were mechanical, not electrical. Things like freedom from embrittlement after welding, and greater mechanical strength at both elevated and very low (i.e., cryogenic) temperatures. In short, the same basic picture painted by Dick Burns.

Just to make sure, I tried contacting the metallurgy department of one of the local universities. They in turn referred me to an expert in private industry, whom they described as the "most knowledgeable person in Australia" on the subject of copper variants and their characteristics.

The expert concerned was Mr Colin Campbell of Austral Bronze Crane Copper, who was out when I rang. But he rang back later in the day, and very kindly gave me a rundown on the comparative features of ordinary ETP copper and OFC – or as he preferred to call it, OFHC (for oxygen-free high conductivity copper).

Mr Campbell explained that OFHC has actually been around for some time, despite its relatively recent appearance in hifi equipment and other consumer electronics. Apparently it was originally developed by a New York based refinery known as American Metal Climax Inc., or "AMAX" for short. By melting and casting the final ingots in an inert gas, the company was able to achieve oxygen levels as low as .0003% – a couple of orders of magnitude smaller than in ordinary electrolytic copper.

He went on to explain that traditionally, the main edvantages of this much lower oxygen content (in the form of copper oxides) were mechanical. One was freedom from "hydrogen embrittlement" following welding; another was greater ductility – the ability to be drawn into much finer wires, without breakage or weakening. And thirdly, he noted that an important feature of OFHC is that it has a very tightly bonded layer of oxide on the *outside surface*, presumably because of the lack of oxides inside.

It is this characteristic which apparently makes OFHC particularly suitable for glass-metal seals, such as those required where wires must pass through the glass envelope of a valve.

But what would be the advantage of oxygen-free copper for ordinary electronic components and wiring? Mr Campbell agreed that there is virtually no difference between the electrical conductivity of OFHC and standard electrolytic copper of the type produced at Mount Isa. So that superficially, he too was unable to explain what possible advantage OFHC might have for electronic components, or the wiring inside a hifi amplifier or DAT recorder.

He was cautious about drawing any firm conclusions from this, however. In fact he suggested that we could well be wrong, in assuming that the Japanese manufacturers were using OFHC because of any electrical advantage over ETP copper. The real reasons for its use might be rather different:

"The Japanese are very smart, especially when it comes to manufacturing. But they don't always make clear the real reasons for doing things. It was your assumption that their reason for using OFHC in certain electronic equipment was because of its superior electrical conductivity."

"So if that doesn't appear to be the case, that's not really sufficient reason for concluding that this use of OFHC is just marketing hype. The real reason for using OFHC could easily be something quite different, which they haven't explained." Fair enough. That's certainly a possibility. Certainly the sales material I've seen didn't offer any explanation as to *why* OFC/OFHC was used in the equipment concerned. It just said that it *was* used, with the obvious implication that this was somehow a *good thing*. As Mr Campbell points out, it was our assumption that this was because of a supposed improvement in conductivity.

Of course we wouldn't have been able to make this possibly wrong assumption if the real reasons for using OFHC had been made clear in the first place. So the manufacturers themselves seem to have contributed to our mistaken inference, if that's what it is.

The real reason?

What then is the *real* reason for using OFHC in this equipment, if it isn't for improved conductivity?

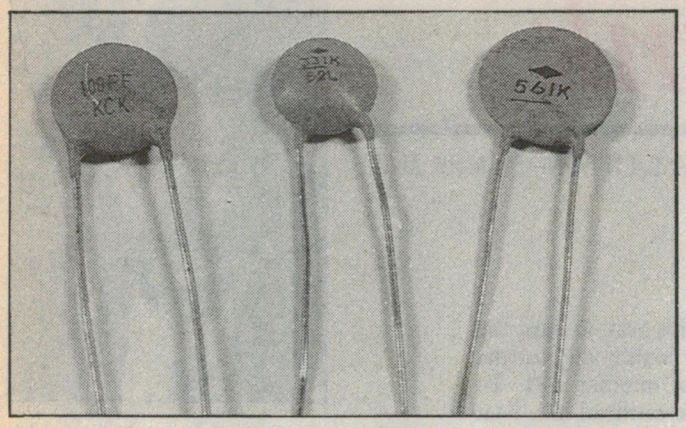
I approached the Australian subsidiary of one of the main Japanese hifi manufacturers, to try and get the answer. The good people there admitted that they didn't know all of the fine details, but undertook in turn to send a query to Japan, to find out from the design engineers themselves.

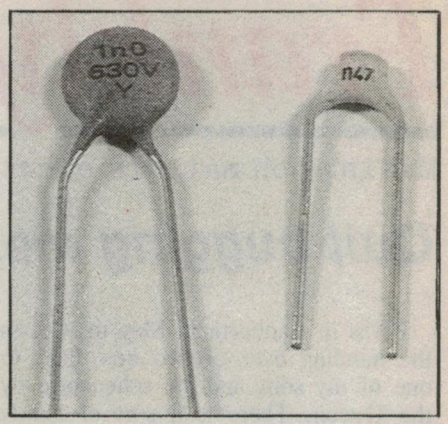
Unfortunately by the time I had to send this month's column away for typesetting, the answer still hadn't come back from Japan. So I guess we'll all have to wait until next month, for the definitive answer!

Tingles and bites

To end up this month, I've received a couple of letters already following on from my column in the July issue about double insulated appliances that give you a "tingle" – and how to find out if they're really dangerous or not.

The first letter was from Phil Allison, a service technician who deals with a lot





Without wishing to renew the great nanofarad argument(!), I offer these pictures. At left, slightly confusing markings on typical ceramic caps. At right, caps with values given in the "dreaded" nanofarads.

of professional audio gear in the Sydney area. In his letter he describes a situation which is very relevant to the subject of leakage and tingles, even though he didn't experience it directly:

The complaint was that performers in a Sydney Hotel were regularly receiving electric shocks, from the microphones used in the house PA system. An electrician had declared the house wiring OK, and others had attempted to find the cause of the problem – without success.

Those receiving the shocks were usually guitarists, whose instruments would be connected to mains earth – and hence they too would be earthed whenever they were touching the strings. It seemed the microphones must be "live", because the guitarists were getting most unpleasant shocks whenever their lips touched the microphone cases.

The mixer-amplifier employed was of a well-known Japanese make, that uses a two-core power lead – i.e., it is "double insulated". When Phil Allison was asked for advice about the problem (over the 'phone), he guessed that this might be the cause of the problem. Having no mains earth it would be possible for the unit and anything connected to it to "float" at some considerable voltage above earth, as noted recently in Forum.

As a temporary cure only, my advice was to try running a jack lead from a spare input on the mixer to a spare input on one of the normally earthed amplifiers on stage. This would hopefully bring the mixer-amplifier to earth potential.

I was told that this measure completely eliminated the problem. Eventually the mixer-amplifier's two core lead was replaced with a standard three core type, and the double square symbol on the back of the unit effaced as recommended in Forum.

It is likely that the current involved in these shocks was quite small, probably too small to cause injury. But the problem was very real, and unacceptable to the performers concerned.

My view is that "double insulated" equipment has its place, but that audio equipment, especially PA systems, must be securely tied to mains earth in order to function properly in typical installations.

I should like to hear comment about the above incident from importers of "double insulated" musical equipment, as this would surely not be an isolated case (no pun intended).

A very interesting case Phil, I'm sure other readers will agree. The human lips are a very sensitive part of our anatomy, and I imagine that even supposedly non-dangerous currents applied to them produce a most unpleasant experience. This certainly seems to be a situation where earthing is very desirable, rather than double insulation.

Like Phil Allison, I too would be very interested to hear comments from the equipment importers as to how they can justify continuing to supply this kind of gear with double insulation rather than earthing.

The second letter came from our old mate Jim Lawler of Hobart, also an experienced service technician. Jim's letter brings to light another aspect of double insulation and two-pin power plugs, which I for one hadn't noticed:

My son has just moved house, and he complained to me that none of the power points in the lounge or bedrooms of his new house would work. Only the kitchen socket, where he used the toaster, would accept a plug. All the rest appeared to be blocked in some way, and he couldn't use his hifi, his bedroom clock, or even his electric razor.

I tried several of his appliances in various sockets, but none would accept a plug. But the previous tenants had not complained, so there had to be a simple answer.

When I removed one of the sockets for a closer look, I soon found what I should have suspected from the beginning. The sockets were fitted with "safety shutters" over the active and neutral openings, which could only be displaced by the earth pin of a normal, three-pin plug. But most modern appliances are "double insulated" and are fitted with two-pin plugs.

So I was faced with the task of either fitting three-pin plugs to 15 or 20 appliances, or removing the shutters from eight sockets. On the basis that there were millions of un-shuttered sockets all over the country, I decided to operate on the sockets rather than chop off and replace 20-odd perfectly good two-pin plugs.

Surely this must be the classic no-win situation. I've done the wrong thing by un-shuttering safety sockets. But otherwise I would have also done the wrong thing by fitting three-pin plugs to double insulated appliances! No matter that the earth pin would not be connected to anything...

As I see the rules, only two-pin plugs can be fitted to double insulated appliances. Like so many rules devised by bureaucrats, the double insulated argument is good in principle, but totally out of touch with reality.

Hmmm. Pretty strong words there Jim, and I'm not sure I'd go that far myself. But there certainly seems to be a clash between the desire to have shuttered power outlets, to prevent children sticking things in, risking electrocution, and the trend towards double insulated appliances with two-pin plugs. The two just aren't compatible.

I think I'd have done what Jim did, in the same situation, and remove the safety shutters. But as Jim himself points out, it seems to be a classic case of "damned if you do, and damned if you don't".

Perhaps someone from the SAA will write in and explain the officially sanctioned solution to that one!

Frankly Frank

Musings on matters electronic by FRANK LINTON-SIMPKINS

Quit bugging me, will you!

I was in Canberra in May to witness the handing over of two new flags to one of my sons and his colleagues, by the Queen. There is a sort of family tradition about this flag thing – my wife had been among the spectators when the old flags were handed out by the Queen on a previous visit, and I had often marched around the same parade ground behind a set of flags given by the Queen's father.

As a sort of a secondary event the Queen was in Canberra to open the new semi-submerged Parliament House. I had wanted to personally witness this other event, but since the word was that 1,000,000 people were expected, I was warned off. In the event I needn't have worried, since the TV showed that there was only about one brigade on parade, or around five thousand patriotic horde members of all ranks.

The TV commentators, loyalists to their bootstraps, said that there were 35,000 people and that around 1500 of them were Khoori demonstrators. The true figures were around 500 Khooris and about 4,500 on the terraces. There were probably as many again inside the place. Although I can understand the upset of any people who have had another race move in and take over their country, I suspect the real reason for the Khoori demo was the grossly inaccurate way we pronounce the name of the place. It should really be Camberry after the Bogong Moth, a pre-dawn unsaturated fats delicacy much favoured by the regional tribes before the Europeans came in and renamed the place – firstly "The Limestone Plains" and then "Canberra".

But the Khooris should not lose heart. It took my ancestors 727 years to get rid of the same mob that took over Camberry and still a quarter of the country is gripped hard in the Sassenach fist. I should also point out that 200 years after European settlement began and 87 years after Federation it wasn't an Australian that opened the new house. In the words of a song from my mother's country, "One day we'll all be civilized. Won't old mother England be surprised."

The point of all this was to link the bugs that provided a healthy diet for the Khooris with bugs of another sort. To watch the show at the artificial hill, I sat back five kilometres away and saw the whole thing on TV. There I got a better picture of the new sous terrain and the Firbolgs therein than anyone on the site, except for the men in the security control room. I had a proper CIA view of the event.

In comfort and sipping my Earl Grey's I saw the Queen do her shtick with the keys, saw her wonderfully controlled expression as she undraped a portrait statue of her good-self, in short I saw the whole show. I can't help feeling that the statue was provided in much the same spirit as the slave who was required to ride behind a Roman General during a Triumph and to constantly remind the General that he was mortal.

In a sense, with the aid of several TV channels and with the legal connivance of the Speaker of the House, I had successfully "bugged" the whole show. As I did my bugging and saw the modern Kaaba of the Oz Haj, I was reading of a truly fascinating bit of gear for the Space age peeping Tom US style.

If you are still a relatively gelid spy, a private detective or just curious, this device is for you. It consists of a car radio aerial with a tiny lens at its top. From this lens a fibre optic link comes down to a transmitter/TV camera located in the top of the car's body panelling. The aerial rotates slowly, giving the viewer a panoramic view. The camera transmitter sends the pictures to a remote monitor. The picture provided by the bug is said to be excellent, but then they promised that from SBS – and you all know how poor US colour is.

After reading this I have become unable to pass a parked car without giving its radio aerial a crafty look to see if it is turning. Just before I sat down to write this, having returned from Camelot to Paddington, I had this terrible urge to check how many cars in my street were equipped with TV.

A swift count from behind the front curtains showed that at least six cars in my vision range had been parked with their aerials up. Considering the nature of the feral patrons from the local pub, to leave your aerial up in Paddington is to tempt fate and the flat 'at mob.

Then I saw a local, one of us, approaching. Doc is a pantheist and talks to trees, even wattles – those wretched wimpish things. Now a discussion of Talmudic intensity with a macho great Moreton Bay fig would not surprise me, but I can't understand wattle tattle.

Doc is a retired cosmetic surgeon who has an order of Australia for services above and beyond the call of duty during the re-location of elderly females' ears, after several face lifts and also for charging fees beyond the dreams of avarice. I went out to greet him. "Doc", I said over the recently installed anti-Mormon fence, "I have been to Canberra to see the Queen". "Why so far Franko?, you could have walked along Oxford Street on late shopping night and seen hundreds", he reasoned. To avoid a conversational dead end I told him about the TV equipped car radio aerials.

Doc then told me that I had nothing further to fear from the seeing-eye aerials as he had a plan, intelligence that filled me with alarm. He reached into his gold initialled calf hide briefcase and removed a roll of surgical sticking plaster, plus a pair of fearsomely clinical scissors. Leaving me he began gracefully wrapping the tops of car radio aerials with the plaster.

Since the day was the one when the local Police collect unpaid parking fines, a young cop and coppette watched in bewilderment as Doc wrapped the aerials of their divisional Magna. We were now safe from observation via car radio aerial TV. Doc had once again earned his right to his Order of Australia, with scalpels, gumleaves and gold Amex cards.

Spy cameras in the aerials of Camiras are bad enough, but for sheer horror I commend to you the old microphone in

the loo down pipe trick. This works best if the people whose words you hang-on have a loo close to where serious matters are discussed. The surface or the water in the bowl vibrates like a microphone diaphragm as people talk nearby. This vibration is transferred up the down pipe to the cisten. The buggers' pickup is located in the cistern. There would have to be a noise overload cut-out to preserve the listeners' hearing.

All things considered I decided I wouldn't tell Doc about the loo bug. Who could say what a desperate man might do with his sticking plaster. I was also concerned for the health of his poor wife, who has only a mere four of five megabucks between her and the pension/meals-on-wheels.

All this talk and thought of bugging etc. reminded me that during a recent committal hearing of charges against the somewhat vocal Mr Grassby, AKA Roy G Biv, it was hinted that the telephone of his legal counsel had been bugged. Like much else about the case it had all been so clumsy and outdated. Couldn't the buggers have used a laser mike on the windows of the learned man's chambers? A bug in his loo? A rifle mike as he and his client walked across the road to lunch at Pomeroy's? Are the National Crime Commissionaires so ill equipped? Are the doughty men on loan to the NCA from the Feds unable to borrow equipment from the Americans like all our other security community members do?

We all know that the Americans have, for over a quarter of a century, been operating a series of party lines with UK international telephone callers, copying any interesting telexes, fax etc. and with the full permission of UK governments. Since the Americans probably haven't told our governments if they are bugging our local communications as well, they may be able to offer the NCA quite reasonable terms on a comprehensive bugging service.

But in case the Yanks don't trust the NCA here is a partial list of freelance bugging equipment currently on offer in the US and probably on sale in the shops in the transit area at Frankfurt airport if they want to save going to the US. The list, the partial list that is, includes such things as a bug that can pick up and translate typewriter sounds; transmitter bugs that are labelled Telecom or whatever that live permanently in telephone handsets and operate continuously; bugs in handsets that double as small anti-personnel mines in cases where convictions cannot be obtained to judicial or legal interference; microwave monitoring of computers or word processing units; transmitting bugs that can be stuck on the outside of windows; fibre optic devices; laser mikes to pick up voice vibrations from windows; loo bugs and the favourite one, the telephone infinity bug.

All are illegal to use in Australia, that is they are illegal if used by anyone, but this will only stop civilians, not, as we have seen recently in NSW with the Age Tapes and in other places, the law enforcement authorities.

Doc headed off up the street taping up aerials and the young cop came over to ask me if I knew what it was about. "He's a few sandwiches shy of a picnic", I said, "But totally harmless now he is no longer practising as a doctor ". Sometimes it is best not to alarm even our nice young Paddington cops with too much detail.

I went back inside and turned on the SBS test pattern. The music over was Handel's *Messiah* and as I waited for the climax, I wondered who might be listening to me listening to Handel – and who is listening to you turning these pages. The Handel changed: "Why do the nations so furiously rage together? And why do the people imagine a vain thing?"

Welcome to the goldfish bowl. EA

At what age are you co

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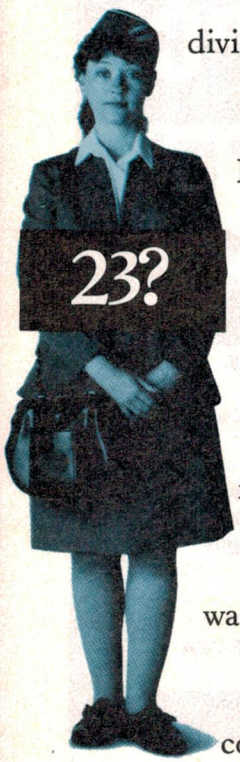
All in all the instructor felt he had it made. But after a while, he got to thinking, "What am I going to do when I get older? I can't spend the rest of my life diving."



Too old for new tricks?

His friends thought he was worried about nothing. "Just about anyone would give their right arm to do what you do," they said. "And besides, you're only 22." Still, the instructor's concern continued, so he looked at a paper to see what was going, and made a few calls.

The enquiries led him to the conclusion he'd suspected; that he was too old for any worthwhile training or apprenticeship schemes.

Even if he'd been 18, he was told, he'd have been considered a dog too old for new tricks. This story does have a happy ending, however.

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nsidered over the hill?

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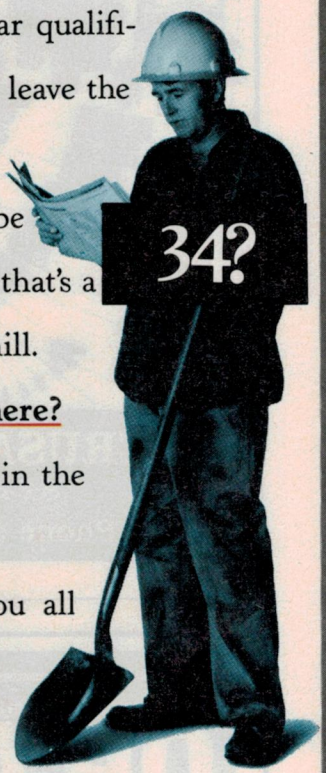

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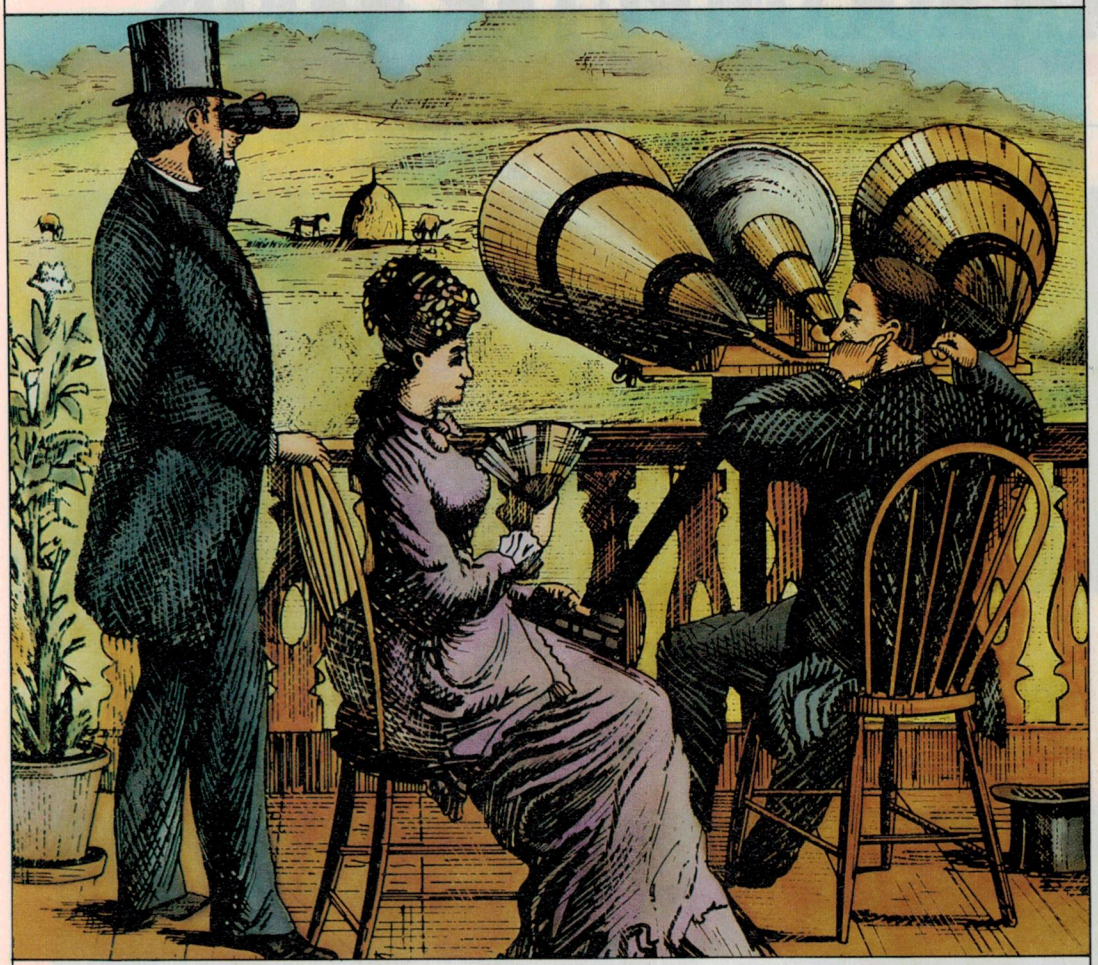

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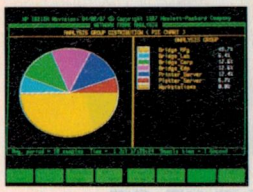

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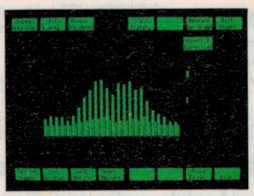

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TMS70C42	256	4K	–	–	–	24	0/8	1	3	
TMS70C08	256	–	–	–	–	30	0/4	1	3	
TMS70C48	256	4K	–	–	–	46	0/8	1	3	
TMS70C82	256	8K	–	–	–	24	0/8	1	3	
TMS77C82	256	–	8K	–	–	24	0/8	1	3	
TMS77C01	I/O	EXPANDER				24		–	2	
TMS73C41	128	4K	–	–	–	16	0/17	–	2	VF DRIVE, A/D
TMS73C42	128	4K	–	–	–	8	12/1	–	2	LCD DRIVE, A/D
TMS73C43	128	4K	–	–	–	32	0/23	–	3	HIGH SINK OUTPUTS
TMS73C44	256	4K	–	–	–	20	8/5	–	2	LCD, DTMF, CLOCK
TMS73C81	192	8K	–	–	–	28	0/27	–	2	VF DRIVE
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TMS370C310	128	4K	–	–	–	21	1/0	1	2	
TMS370C810	128	–	–	256	4K	21	1/0	1	2	
TMS370C050	256	4K	–	256	–	46	9/0	2	3	A/D, 128K MEMORY
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Recording Australia's Oral History — 5:

Now you've got it, use it!

In this last article of his series, the author describes how programmes are actually put together. He explains things to watch if you want to achieve a professional result, and also gives advice on the tricky business of cueing compact cassettes.

by JIM LAWLER, MTETIA

Telling you how to assemble and use the equipment described in the previous pages can best be done by explaining something of how I want about production work on the Hobart OARTS exercise called "Cobbler's Last".

The first half of this 50-minute programme comprised five short talks of three to five minutes each, linked by a presenter and appropriate theme music. Each of the speakers was a member of OARTS (or Radio 55 as we prefer to call ourselves) and we were talking about our own hobbies or professions. Hence the name "Cobbler's Last".

The second half of the programme was a discussion between a father and son about their respective musical preferences, interspersed among the records they were talking about. (Called "Track for Track", this experimental programme is worthy of development into a fully professional series.)

Three of the five short talks were pre-recorded in my studio. I used a dynamic microphone into the Realistic mixer, then to all four channels of a large AKAI 630D open reel recorder. This gave me, in effect, a mono recording using almost the full width of a quarter inch tape. The other two talks were pre-recorded in the ABC's studio 716 using professional equipment. (I offered a leather medal to any of my colleagues who could tell me which was which. The medal is still unclaimed!)

The links in "Track for Track" were pre-recorded with a professional Shure microphone and a Nagra recorder at the speaker's home. They were presented to me on 5 inch reels, along with the relevant music on discs.

The first half of the program was assembled in the ABC's Studio 716. The presenter played the theme and read the intro from the studio, then I played the pre-recorded talk off tape in the control room. Then more presenter, more pre-recorded talk, and so on until we had completed the script. It was convenient and easy to do this at the ABC, but there was nothing that couldn't have been done at home.

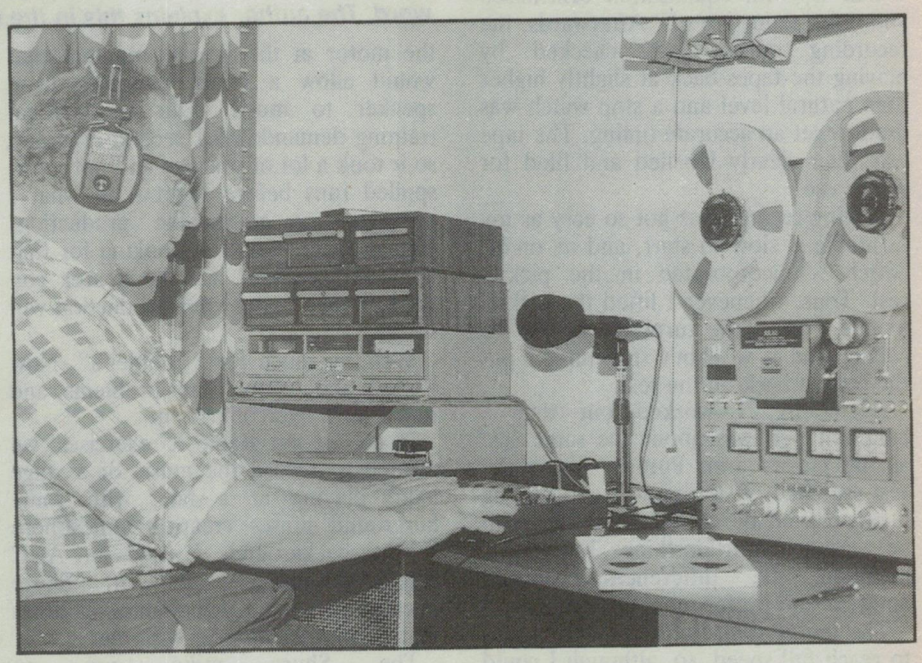
By the time we were ready to do the second half of the programme, we had run out of studio time. I offered to do the rest of the production at home, and it was when I came to assemble "Track for Track" that the hard work started.

To begin, I cued up the presenter's introduction on the open reel machine (I used a metal tape cassette to record my master copy). I put the intro on the cassette, then paused to reload the open reeler with the first link and to cue the theme music disc. Then it was play the opening music, fade down at the appropriate spot and fade up the link over the music.

Because I only had one of everything, I had to pause the cassette recorder at the end of the first link to cue the next disc and the second link. I had to repeat this sequence over and over until I had all the material assembled. It would have been much easier with two turntables and two recorders, but even so, it worked out quite well.

I made use of my open reel machine simply because I had it. Otherwise I could have just as easily have used a second cassette recorder, although they are not so easy to cue accurately.

Your Oral History tapes will probably



The author in his home studio. At right is a Akai four-channel open reel recorder, while to the left of the microphone is a Technics dual cassette deck.

not be as complicated as "Cobbler's Last". It is unlikely that you'll be adding music to your material, and you won't have to assemble tapes from three or four different sources. But you might want to mix in sound effects from disc or tape, and the procedures I have outlined above should give you an idea of how you might go about making your programme.

The home studio

For the pre-recorded talks that were done at home, the talent was seated at a desk with the microphone on a short stand, about 12" from the mouth. Any closer risks having the speaker's breath popping the mike, and any further away risks reverberation problems. My "studio" was a small workroom that was once a bedroom. It contains a bed and wardrobe, and lots of recording and video equipment. There is no special sound treatment on the walls, so it is moderately "live".

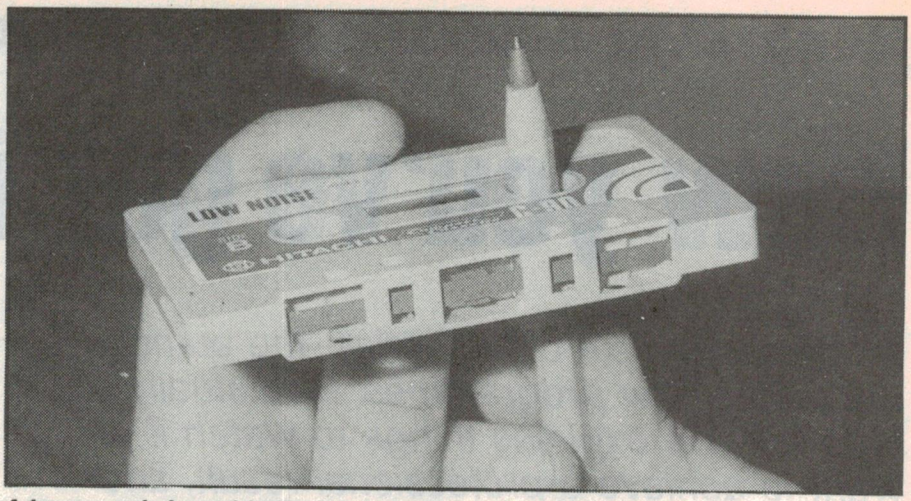
If the recording venue is too "live", echoes and reverberation will distort the speech and make it hard to understand. On the other hand, if the studio is too "dead", the speech sounds the same way. Nothing can be done to save an over-live recording, but in the latter case, the recording can be rescued by adding artificial reverberation using a special effects generator. Doing this properly is a near professional exercise and is beyond the scope of these articles.

The signal was fed to the recorder flat – that is, with equalisation centralised and noise reduction off. Afterwards, the recording quality was checked by playing the tapes back at slightly higher than natural level and a stop watch was used to get an accurate timing. The tape was then clearly labelled and filed for future use.

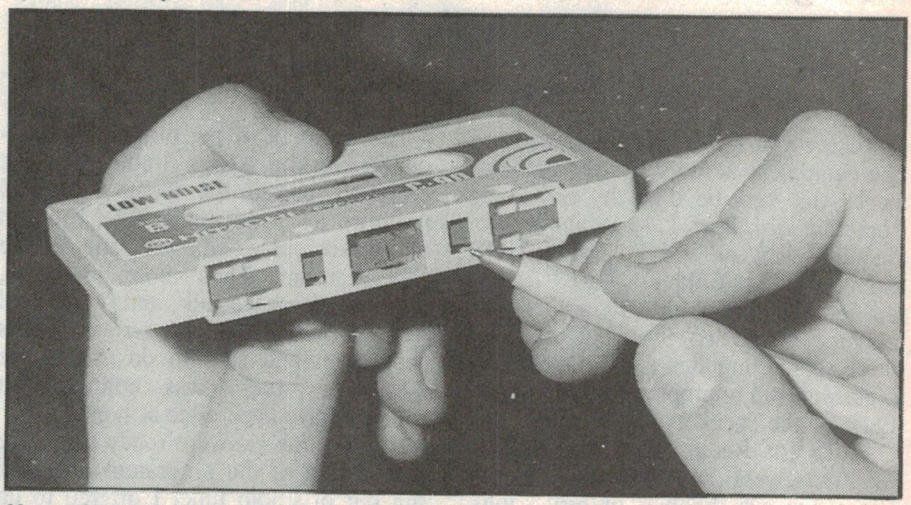
Playing records was not so easy as my turntable is slow to start, and its on/off switch is incorporated in the pickup rest. Thus, whenever I lifted the pickup to cue a disc, the turntable started to rotate, and it wouldn't stop until I put the pickup back on the rest.

Eventually, I worked out that a ballpoint pen was about the same size as the pickup arm. Putting this in the rest switched off the motor, and pulling it out started the motor. This seems to be a crude way to do things, but it does highlight the differences between amateur and professional equipment.

The motor took two and a half turns to reach full speed, so, although I could cue it accurately enough, it was something of a tossup whether I started the motor at the precise moment that would allow a smart transition from speaker to music. Our professional training demanded 0.1 second accuracy, so it took a lot of practice and not a few spoiled runs before I got it to what I considered a reasonable production. You probably won't be looking for that kind of precision, but the nearer you get to it, the better your production will sound.



A hexagonal-shaped ballpoint pen or pencil can be used to rewind a cassette by small and precise amounts.



Here the pen indicates the point to which the tape should generally be rewound (from the middle of the centre head opening) to edit one average word. The author explains this in the text.

Well, so much for "Cobbler's". Now I'll talk about some other problems, and how I have overcome them.

In one of our Radio 55 exercises, we wanted to record the music of a stage band playing at a fair, with some fairground noises creating atmosphere in the background. I used an ABC Nagra recorder and a Shure microphone, but I was wishing at times that I had my own gear with me.

The Shure mike was an omni-directional unit, of moderate sensitivity. It was a model intended for close-up interview work but even so, it did a reasonable job of picking up the all-round sounds of the fair. But it flopped badly for the music. I could not get very close to the band so I had to settle for a recording of fairground noises with the band music in the background, instead of the other way round.

A uni-directional or cardioid mike could have given me a better balance. By pointing the mike axis at the band I would have maximised the music and minimised (but not necessarily eliminated) the fairground noises. Oddly enough, I did have a suitable mike with me that day, but I didn't have the right adapter plug to match my mike to the ABC's recorder. See what I mean about standardisation of plugs and sockets?

Earlier in this article I mentioned a programme called "Track for Track", featuring a father and son talking about their kinds of music. On listening to

their pre-recorded links, I felt sure that they had been recorded in different places and probably at different times. Dad could have been in a kitchen or some other very "live" venue, while the son sounded as though he was in the carpeted lounge, with heavy drapes on the walls.

I have been since assured that they were sitting at the same table, at the same time. The sound difference comes about because the father was facing a hard plaster wall several metres or so in front of him. The son, on the other hand, was facing a nearby wall which was draped with medium weight curtains.

If these speakers had turned through 90°, they would have shared equally in the live and dead walls and their sound quality would have been much more uniform. This unfortunate placement is an object lesson to all of us who aspire to record interviews of a uniform high quality.

In the third of these articles, I mentioned special phono discs that can be copied without infringing copyright. These are mostly sound effects made specially for amateur movie buffs, and they are quite suitable for our purposes. However, why not build up your own file of special effects?

I have been doing this for years, and now have a fair sized library of effects, ranging from "cracker night" to "rain on a hot tin roof". There are all kinds of things including aircraft noises, chain saws, thunderstorms, bird calls, trains etc. The only thing I haven't got is a farmyard scene and I need that for a forthcoming "Radio 55" exercise. I suppose I'll have to go out to a farm and put some pigs on tape!

Cueing cassettes

I have frequently mentioned the difficulty of cueing cassettes. It is not impossible, but it does take care and patience. The following is a description of what I have worked out, and I think it should work for you.

If you look at the front edge of a cassette, you will see five holes, three big ones and two small ones. The centre of the big one in the middle is the spot we are interested in. That is where the record/play head fits and that is where the tape will sit if you stop the machine right at the beginning of the new material you want to record.

Unfortunately, we humans are not fast enough to stop the machine as the first syllable of the wanted word starts.

The author recording stereo sound effects on location. The two recorders are powered from a pair of 12V batteries via a 300VA inverter.

Probably the whole word has passed before we react. So we have to "guesstimate" the length of tape occupied by that word and then wind the tape back that far, hopefully to a point just before the start of the word.

Cassette tape runs at 48mm per second (or 1-7/8" per second for us pre-metric types), and a second will hold about three longish words or four average words at normal speaking speeds. So for one average word, we must wind the tape back 12mm – which just happens to be to the near edge of the small hole adjacent to the centre hole.

So, the procedure is this. Play the tape up to the point to be cued. If there is one, note the word immediately ahead of the wanted point. (This will shorten your reaction time so that less tape need be rewound for a proper cue.) In either case, press the stop button as soon as you hear the first word start. The machine should stop as the word finishes.

Then remove the cassette from the recorder and put one of those hexagonal ballpoint pens through the left hand reel hub. You can turn the reel with the pen and so wind back the tape. But now comes the tricky bit.

There are no marks on the tape to show you how far you have wound back. You can guess, or you can make a mark on the tape with a very fine topped felt pen. But beware. The side of the tape you can see and mark is the side that contacts the record/play head. And anything that marks the tape can foul the head, causing poor response and premature wear on tape and heads. I suggest you use a felt tip pen, but make only the tiniest mark and be prepared to clean the record/play head frequently.

Having wound the tape back to what you imagine to be the beginning of the part you wish to copy on to your new recording, it only remains to record your introduction onto the new tape then press the start button to play the incoming tape. Sounds easy when you say it like that, and it is easy. But you'll chew your fingernails back to the elbows before you get it right.

The only answer is practice – lots and lots of practice. Once you get the feel of how you and your recorder are reacting together, then it starts to come easier. If you do enough work and practice long enough, you'll one day become as adept as those Radio Production Officers at the ABC who seem to press the right button even when their eyes are shut.

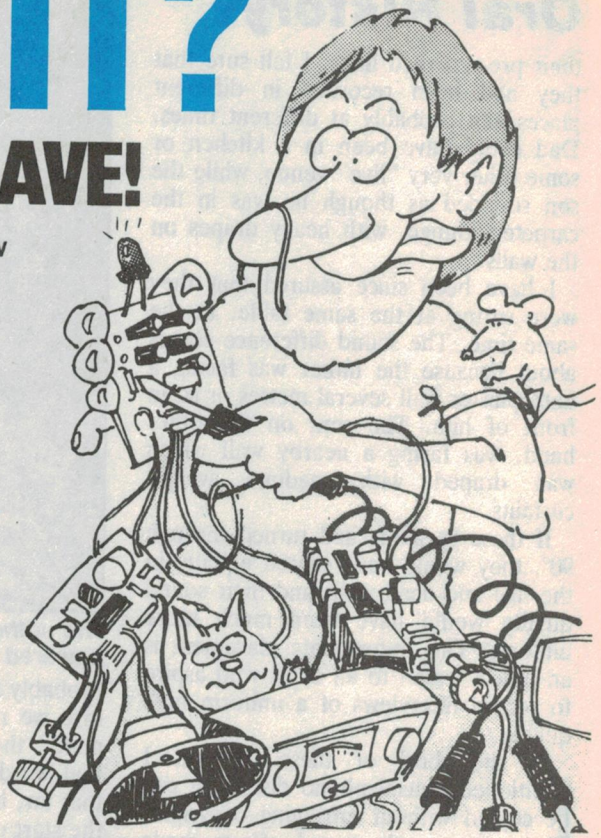
And so we come to the end of this series of articles about the home recording of our nation's oral history. Over the last five months we have looked at the reasons why, the equipment for and the techniques by which we can save for all time the historical trivia that shows how we got to be what we are.

Modern cassette recorders allow anyone to be an oral historian. Perhaps in ten years time every library in the country will have its file of local history, recorded and assembled by exponents of this, the newest of all hobbies.

I hope these articles will have provided you with the motivation and knowledge to join in. EA

WHY BUY IT?

BUILD IT YOURSELF & $AVE!



Building your own saves you money - especially at the low, low prices of our amateur & related kits this month (see below). But there's more reasons to "roll your own" than ***just*** to save money...

- You'll keep (or maybe regain?) those construction skills you had back in the good ol' days - when all there was available was to do it yourself.
- In these days of "black boxes" it's to easy to lose those important - perhaps elementary - skills such as soldering technique, component dress, wiring, even component identification!
- You'll be able to enter those "home brew" competitions that used to be so much a part of our hobby. Today they're all but forgotten in many instances.
- You'll get the piece of gear - test equipment, transceiver, amplifier, whatever, far sooner than having to wait until you've saved for it.
- Perhaps most importantly of all, you'll be proud to say "I built it myself!"

BIG SAVINGS THIS MONTH ON AMATEUR & RELATED KITS:

UHF Amateur Transceiver
The ideal way to get onto 70cm.
Cat K-6300 Was $249.95
THIS MONTH: $199

40/80CH Upgrade Kit for UHF Transceiver
Doubles the number of channels you can access. Cat K-6301
Was $12.95 **THIS MONTH: $5.95**

70cm Preamp
Not just for the kit transceiver: get a few more dB out of any commercial receiver too — and cheap! Cat K-6306
Was $21.95 **THIS MONTH: $9.95**

UHF GaAsFET Preamp
When you really want performance, try this beauty! 13dB gain, includes full tx/rx switching. Cat K-6309
Was $129.00 **THIS MONTH: $99**

UHF Power Amp
Extra oomph out, too: 50W ish from 2W drive! Includes carrier detecting switching. Cat K-6307 Was $279.00
THIS MONTH: $199

UHF Wattmeter
The inexpensive way to keep your 70cm station up to scratch. Cat K-6312
Was $49.95 **THIS MONTH: $39.95**

2m Amateur Transceiver
Why not make a pigeon pair? Covers full 2m band . . . a great "big time" project for novices (needs fair level of technical skill). Cat K-6308
Was $249.95 **THIS MONTH: $199**

2m GaAsFET Preamp
Like its 70cm brother, it will put some SIG into your signal! Cat K-6311
Was $129.00 **THIS MONTH: $99**

Need A Supply?
Matching 13.8V power supply for VHF or UHF transceiver. Cat K-6310
Was $49.95 **THIS MONTH: $39.95**

How About A Linear?
Perfect for the kit — or handheld, etc. 100W out from 15W in (40W from 2W). Cat K-6313
Was $299 **THIS MONTH: $249**

Or A Power Meter?
VHF Wattmeter is easy to build, a must for your 2m station. Cat K-6316
Was $49.95 **THIS MONTH: $39.95**

And Just In Case You Have Too Much . . .
Attenuate it! The 50 ohm attenuator kit gives you up to 63dB attenuation in 1dB steps from 50 to 500MHz.
Cat K-6323 Was $79.95
THIS MONTH: $49.95

HF Transceiver Slashed, Too!
Covers 500kHz of HF, with 30W PEP output. As supplied covers 80 metres, upgrade kits below give you other bands. Cat K-6330
Was $399 **THIS MONTH: $299**

Upgrade kits to suit — Half Price:
40 metre K-6332 20 metre K-6333 15 metre K-6334 10 metre K-6335
Were $39.95 each . . .
THIS MONTH: $19.95 ea.

100W+ Of HF Muscle
10 to 14dB gain on all HF bands — expect around 150W PEP or so from a 5W input on all bar 28 (3dB lower). Cat K-6331
Was $379 **THIS MONTH: $299**

100 W On SIX, Too.
All-mode amp needs only 6W drive for 100W out. Includes carrier operated relay. Cat K-6349
Was $329 **THIS MONTH: $279**

And A New DIY SW Receiver:
Features 3 bands from 0.48 to 17.12MHz, a great "start-up" kit (great for school projects). Now available in limited quantities in all DSE stores. Cat K-6355

ONLY $79.95

HURRY — SOME STOCKS LIMITED!

LIMITED QUANTITIES OF THESE KITS AVAILABLE AT ALL DICK SMITH ELECTRONICS STORES . . . OR PHONE YOUR ORDER DIRECT TO TOLL FREE (008) 22 6610 (SYDNEY AREA 888 2105)

DSX PRESS DICK SMITH ELECTRONICS EXPRESS ORDER SERVICE

DICK SMITH ELECTRONICS

NEW KITS THIS MONTH!

...AND A FEW FROM LAST MONTH

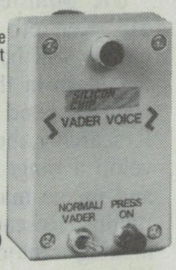
Vader Voice

Shades of Star Wars! The kids'll have a ball with this one: just speak into it and your voice comes out just like Darth Vader's! Nifty little kit, complete in one zippy box.
Cat K-3510

Perfect Beginner's Project!

As seen in 'Silicon Chip'

$29.95

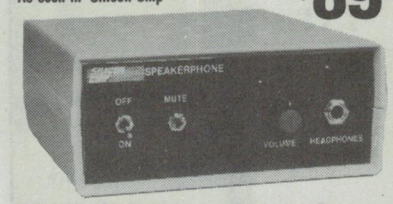


Hands-Free Phone

You could spend hundreds of dollars on a hands-free phone. Or you could build this kit. Simple, effective – and cheap! Use in conjunction with existing phone for full two-way hands-free conversation. Cat K-3100

As seen in 'Silicon Chip'

$89.95



Studfinder

If you've ever hammered a nail into a wall – and missed the stud – this one's for you! Easy to build (one night project) is perfect for the home toolbox. (Sorry, it cannot detect the other type of stud!) Cat K-2723

As seen in 'Electronics Australia'

$19.95

Guitar Practice Amplifier

Short form kit.(PCB & components only – you decide which case you want to put it in) giving a neat little 8 watt amplifier for guitar and similar practice.
Cat K-3548

As seen in ' Australian Electronics Monthly'

$19.95

Lab Power Supply

35 volt, 2A supply for the workbench, lab, technician or hobbyist. Fully metered, extremely easy to build and very versatile. Cat K-3461

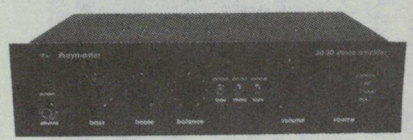
As seen in ' Australian Electronics Monthly'

$109

EA's new 30/30 Amplifier

Remember the twin 25 of a decade ago? We made countless thousands of kits! Here's the up-to-date model: EA's new 30-30 Amplifier. Easy to build, an ideal project for schools, tech colleges, etc – or just the hobbyist who wants a hi-spec kit at a low-spec price.

- 30W per channel
- 0.025% distortion at 30W
- -76dB (phono) and -91dB (line) noise figure



Special 'Short Form' Kit:

We've made up a special kit for this amplifier which includes all the "expensive" and hard-to-get bits – the power amplifier IC's, the transformer, the silk-screened & punched front panel and the printed circuit board.

The other components (such as the passive components, pots, etc) are normal stock lines at your nearest Dick Smith Electronics store (or you may even have many of them in your junk box!). Cat K-5100

As seen in 'Electronics Australia'

Short form kit as described above: $99.95

Our Kit Policy . . .

Where we advertise a kit from an electronics magazine, it is our firm policy to have that kit in our stores no later than the fifteenth day of the month of issue of the appropriate magazine (usually we do much better than that!)

It's part of our committment to the hobbyists and enthusiasts of Australia and New Zealand. We want you to have the latest kits, at the best possible prices, and as soon as possible.

Occasionally, we're let down: an oddball component that has to come from the other side of the world; a shipping or dock strike that delays vital parts; perhaps a magazine that changes its mind about the month of publication (or even about the design of the project!).

If we let you down by not having the kit you want in the store when we've promised it, we apologise. We hope you'll understand that we're doing our very best to fix the problem – but they're not always that 'fixable'. Don't forget that there are 'rain checks' available in all stores to ensure that you don't miss out when the stock arrives – you'll get it for the price advertised and written on the rain check.

Dick Smith Electronics.

At Last! Recently Released Kits

At time of going to press, there were good stocks of these in our stores. But don't blink . . .

Discolight

Move over, Musicolor: Discolite is here. It's the latest in colour organs, with chaser, audio chaser, etc etc. You want a light show? Discolite is what you want! Cat K-3150

As seen in 'Silicon Chip'

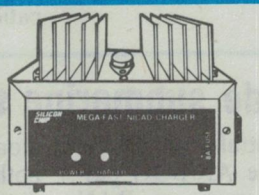
$165

Strobotuner

Accurately and professionally tune virtually any musical instrument with this fully self-contained and portable kit. If you're into music, get into this! Cat K-3550

$54.95

As seen in 'Electronics Australia'



Nicad Charger

Megafast! What you read is what you get – charge 7.2V r/c model type Nicads quickly, but safely: about 15 to 20 minutes, without risk of overcharge. Cat K-3477

As seen in 'Silicon Chip'

$45

Speaker Protector

Your speakers are in deadly peril every time you turn your amplifier on (or if it goes into amplificus cactus). Protect your valuable speakers with this easy-to-build and easy-to-fit kit. Cat K-4008

$37.95

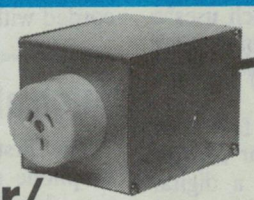
As seen in 'Electronics Australia'

Chair/Tilt Alarm

Nifty little alarm circuit designed to go off on movement (more precisely, change of angle). It's a great way to protect perambulatory property participating in purloining, pillaging, pilfering, pinching or plundering. Cat K-3248

As seen in ' Australian Electronics Monthly'

$11.95



Line Filter/ Conditioner

Commercial line filters cost a fortune: build your own for a lot less. Filters out HF noise, spikes, etc and gives over-voltage protection.
Cat K-3080

As seen in 'Electronics Australia'

$39.95

Budget Power Supply

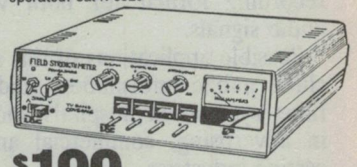
A low-cost variable supply that's ideal for beginners (no need to mess around with mains – it can be powered from a battery if you wish – or any other AC or DC source). No metering, no frills, but economical! Cat K-3460

As seen in ' Australian Electronics Monthly'

$62.50

Relative field Strength Meter

Here's one for the antenna installers, TV techs, etc. Checked out the price of a FSM lately? Build this instead for an xteenth the cost! Gives good relative indication, works on VHF & UHF, and even gives out video signal. Battery/mains operated. Cat K-6329



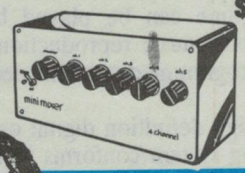
$199

As seen in 'Electronics Australia'

Mini Mixer

Here's a great beginners project – with specs that make it good enough for serious use. 4 input mixer suits mics, guitar, etc – very simple to make. Cat K-3039

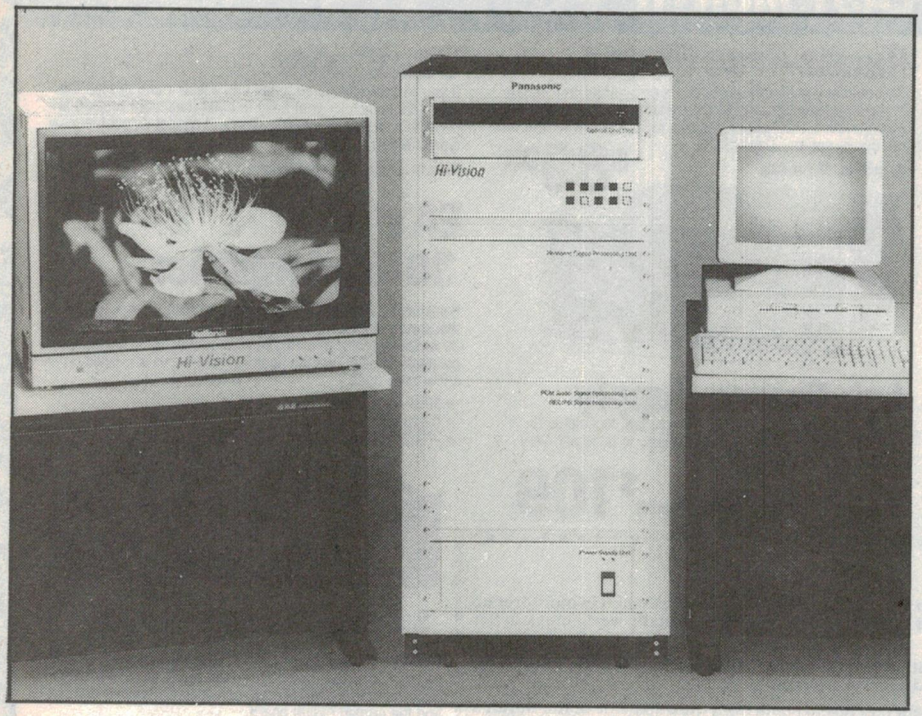
$29.95



As seen in ' Australian Electronics Monthly'

DICK SMITH ELECTRONICS

News Highlights



Matsushita develops first HDTV optical disk

Panasonic Australia's parent company, Matsushita Electric Industrial has announced its development of the world's first high definition digital optical disk recording system, which uses a 12" phase-change write-once optical disk with 2.6 giga bytes of memory capacity per side.

The technology features a fast read and write speed of 18Mbps for recording and playback, as well as a digital recording format for both video and audio signals.

Possible applications of this system include public information guides, video filing systems in hospitals and schools, in advertising, commercial and broadcasting industries.

A maximum of 600 still pictures can be recorded without audio, or 500 still pictures with one hour of stereo sound, can be stored on a removable phase-change type optical disk. Each still video frame can be played back with continuous music reproduction or computer programmed random access playback.

The high definition digital optical disk recording system conforms to high definition SMPTE 240M studio format of ATSC (Advanced TV Systems Committee) and SMPTE (Society of Motion Picture and Television Engineers). It can also be applied to the current NTSC TV format. In this case, a maximum of 6,000 still pictures can be digitally recorded without audio.

UK steps up HDTV research

Britain is to increase its backing for plans to develop a high definition television system by 1.7 million to 4.8 million Sterling.

UK Minister of Trade and Industry Mr Kenneth Clarke says the extra money will be used to support the participation in the project by the Quantel company and the British-based Philips Research Laboratories. Quantel will develop a range of high definition editing and image manipulation equipment and Philips Research Laboratories will be making a major contribution to research into picture analysis and coding techniques associated with the transmission and display of high definition signals.

High Definition Television uses approximately twice the number of lines compared with standard definition, to produce and display TV pictures of a quality comparable to that of 35mm film.

The aim of the HDTV project, which involves some 30 European industrial companies, broadcasters and research institutes, is to define a standard for HDTV which is compatible with the MAC (Multiplexed Analogue Components) transmission system being introduced for Direct Broadcasting by Satellite (DBS) services in Europe. The project will develop and demonstrate, be 1990, a complete prototype production and transmission system for MAC-compatible HDTV.

Australian-made submarine sonar delivered

The first set of Australian-made hydrophone staves for the AN/BQG passive directional sonar array on RAN Oberon class submarines has been delivered to the Royal Australian Navy by the prime contractor, Plessey Australia.

At a handover ceremony in Canberra, Hon Ros Kelly, Minister for Defence Science and Personnel, accepted the first set of staves from Mr Adrian Turnbull, deputy managing director, Plessey Australia, and Mr Harley Tacey, director of marketing.

Mrs Kelly said, "The AN/BQG is a prime example of cost-effective technology development in Australian industry. The cost savings of this design over the previous one will pay for the development of the local expertise."

The rod-shaped hydrophone staves are mounted on the outer hull of the submarine. Each stave is made up of a number of hydrophones, and the staves, mounted along the length of the hull on both sides, make up the wide aperture distributed array for the submarine's passive ranging system.

The directional arrays currently fitted to the RAN submarines, which the new components will replace as their service lives expire, were developed and manufactured by Unisys in the United States, but the decision was made eight years ago by the RAN in consultation with the then Industry Development Branch to locally develop and manufacture improved staves.

The production cost of the new staves is less than one-third that of the originals. They are more watertight and more explosion resistant than the previous design, and thus more reliable. The new staves have exactly the same acoustic centres as the staves they replace, so the data obtained during years of sea trials is usable without alteration.

TI and CyberLynx to develop CEBus chips

Texas Instruments and the USA-based communications software firm, CyberLynx, have announced an agreement to develop a family of semiconductor devices based on the Consumer Electronic Bus (CEBus). A low-cost local area network (LAN) protocol that allows electrical appliances used in the home to be controlled by other devices, the CEBus is being proposed as a standard under the sponsorship of the American Electronic Industries Association (EIA).

By adding small integrated circuits, or "chips", that incorporate the CEBus protocol into products, manufacturers will enable users to activate dishwashers, thermostats, air conditioners, phones, TV's, security systems and any other type of home electrical appliance incorporating these chips, in most cases using existing household wiring. As a result, these appliances can be controlled from a common set of commands by a control console, telephone or computer. Future versions of CEBus-based products will allow consumers to link electronic devices into wider networks and information services, including new telephone network services, cable TV syystems, public utilities and security monitors.

The CyberLynx trademark, *Smarthome* will be used to designate devices developed under this agreement as well as the end products containing these CEBus devices. The designation Smarthome on an end product will indicate that it will be able to communicate on the CEBus LAN in the home. For example, a consumer will be able to purchase a Smarthome-compatible dishwasher, put it directly into the existing household wiring, and have it controlled by any other Smarthome-compatible products.

John Robinson, Marketing Manager, Semiconductor Division of Texas Instruments Australia Limited stated that, "We believe that this agreement will help the concept of a "smart home" to become a reality, because it ensures that chips to allow creation of CEBus-compatible products will be available from a major semiconductor manufacturer."

"We look forward to hearing from Australian manufacturers who are interested in incorporating CEBus-based integrated circuits into end products."

Webster provides gateway to Apple Macs

Australian manufacturer Webster Computer Corporation has added a new dimension to its product range with the announcement of Multigate.

Jointly developed by the Department of Computer Science at Melbourne University and Webster Computer Corporation, Multigate has two main applications. One is as a gateway between an Ethernet connected host computer running TCP/IP and up to 4 AppleTalk networks. AppleTalk is the networking protocol used by Apple Macintosh computers. Alternatively, Multigate can connect up to 4 AppleTalk networks without the necessity for connection to Ethernet.

With approximately 65,000 Apple Macintoshes operating in networking environments in Australia, Webster is confident of Multigate's success.

MULTIGATE consists of a motherboard with a connection to the Ethernet, a daughterboard with connections to the AppleTalk networks and a power supply. These are all mounted into a compact, attractive desktop cabinet.

The motherboard contains a 10MHz 68010 CPU chip, 512Kb of 1 wait state dynamic RAM, Ethernet with both transceiver and BNC (thin wire Ethernet) interfaces (only one of which may be active at any one time), two RS232 serial ports, and ancillary devices (EEPROM, PROM, timers, and battery-backed calendar clock).

To over come potential media incompatibility problems, the Multigate code may be loaded from either the host computer or the Apple Macintosh. The gateway code is distributed as software rather than firmware which allows for easy and economical upgrades, should they be required.

IEEE seeking the "OzMouse"

The Institute of Electrical and Electronics Engineers will be conducting the inaugural Micromouse Competition at Sydney's Powerhouse Museum, on Saturday 15th October 1988 from 9am to 10pm.

As with other micromouse competitions held in recent years around the world, the goal is to find a self-contained and mobile "intelligent" electronic device which can navigate a large maze and seek out the centre of the maze in the shortest time.

Six groups of enthusiasts from local university/TAFE backgrounds are currently developing devices to enter in the competition, and the challenge is expected to be an exciting one.

The IEEE MicroMouse Competition is an endorsed Australian Bicentennial activity. Admission to the final will be by ticket, as the seating capacity is limited. Further information is available from David Matters, Chairman Micro-Mouse Competition, IEEE Computer Society, PO Box 251, Forestville 2087 or phone (02) 451 1256.

Philips wins award for CCDs

Philips Research Laboratories have won the British Royal Television Society's 1988 Geoffrey Parr Award in recognition of their research and development work on the fram transfer solid-state image sensor, as used in portable and studio CCD colour cameras. These cameras are now in use in Australian broadcast stations.

It is the Society's highest award for engineering.

Mr. Bob Longman, chairman of the Geoffrey Parr Award committee, commented: "This project, which called for high quality development work, is a further step in advancing operational and production flexibility, as the growing use of lightweight and compact solid-state colour cameras is applied to a wide range of program making in the future."

News Highlights

Local manufacturing technology for new phone

New manufacturing technology developed in Australia will be used to build Australia's latest standard telephone, the Touchfone 200.

A joint development between Telecom, AWA and Alcatel-STC, the new phone will have many new features including soft touch keypad, 10 stored memory numbers, last number redial and PABX compatibility. Both AWA and Alcatel-STC will be making the phone.

Drawing on its own R & D facilities, AWA designed and constructed computer-controlled assembly and testing equipment.

The AWA assembly line will produce over 3,000 phones per day for the local market with additional capacity for export orders.

The Touchfone 200 is a major advance in telephone design and has considerable export potential, according to AWA Executive General Manager, Communications, Warwick Bishop.

"The Touch fone 200, as a standard phone, is superior in design and features to every other standard phone sold in the world today."

"We used our own skills and technology to design and manufacture both new components for the phone and highly automated assembly methods."

"The very important speech processing circuit, for instance, was designed at AWA's micro circuit design centre and lians, AWA designed and installed a series of quality control testbeds that will be produced at the company's new $60 million micro circuit plant at Homebush, NSW," Mr Bishop said.

The Telecom developed soft-touch keypad is also regarded as a unique development.

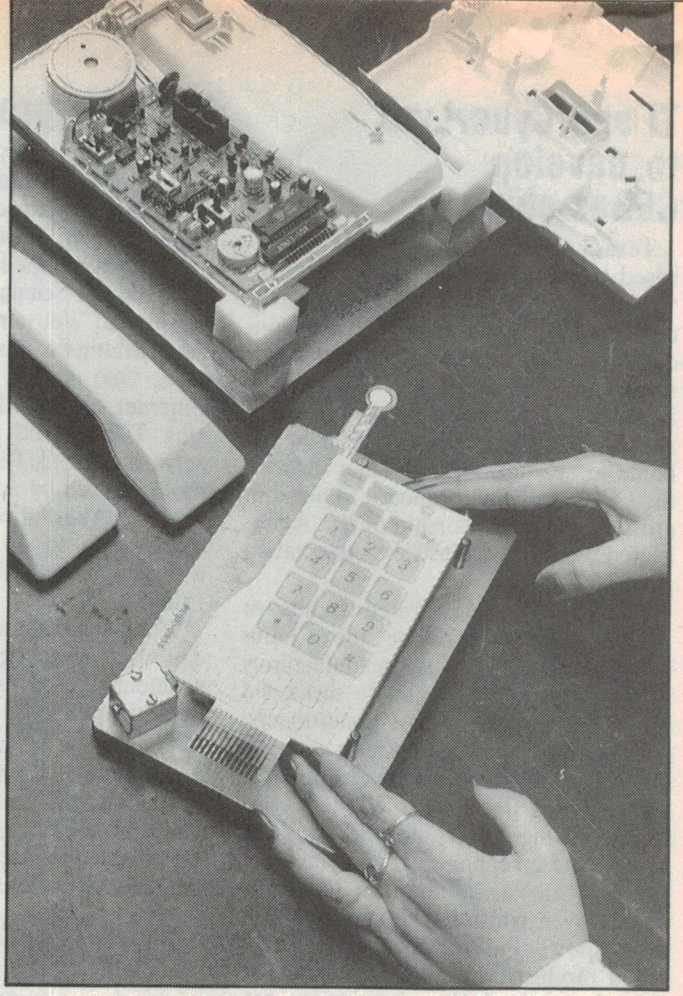
Quality being critical for an item that will eventually be used by most Australian monitor manufacturing and assembly performance at each step.

Alcatel-STC is also installing a $300,000 robotic system at its Alexandria factory to automate its assembly of the printed circuit board that is at the heart of the telephone.

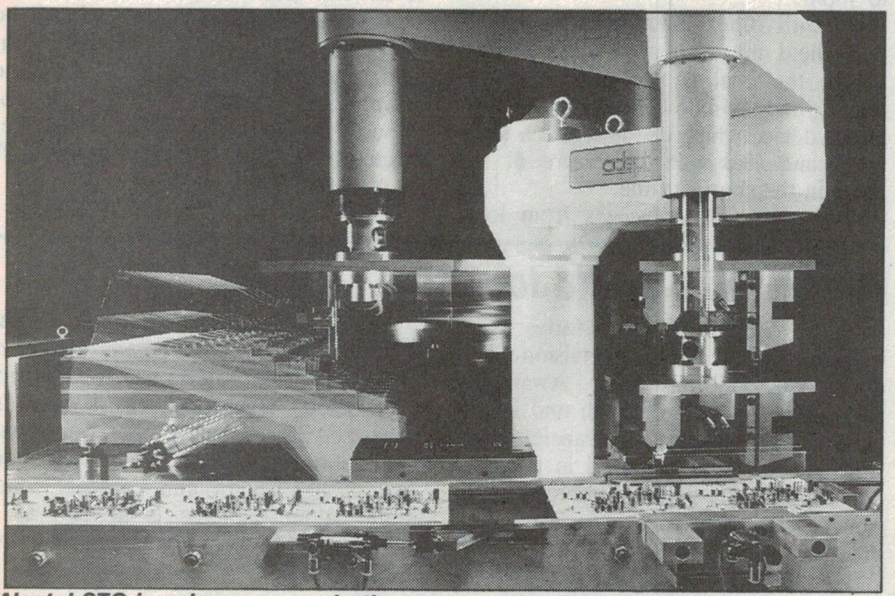
Developed by company engineers in conjunction with the Automation and Engineering Applications Centre in Wollongong, OSCAR (Odd-Shaped Component Assembly Robot) will insert a series of five non-uniform components onto the printed circuit board. The remaining non-uniform components will be handled manually. All other components will be automatically inserted.

OSCAR is an AdeptOne four-axis manipulator robot form Adept Technology in San Jose, California. It is powered by an Adept MC Controller that allows several tasks to be performed at once with no degradation of performance. It can, for example, control a conveyor or communicate with an external computer at the same time the robot is fulfilling its primary function.

The AdeptOne is the first commercial robot to employ direct drive technology. This generates high torque at relatively low motor speeds with no loss of mechanical advantage, making cycle speed several times faster than that of conventional robots.



The main components inside the new Touchfone 200, which has been designed for minimum assembly time. The soft touch keyboard connects directly to the main PC board. (Courtesy AWA)



Alcatel-STC is using a new robotic system called OSCAR (Odd-Shaped Component Assembly Robot) to assemble the Touchfone 200.

ISD introduces IC design education program

Integrated Silicon Design (ISD) of Adelaide has introduced an educational program oriented to the Tertiary Education System. The ISD Educational Program is designed to provide its commercial and proprietarhy Integrated Circuit Computer Aided Design (CAD) Software to tertiary institutions at extremely low cost, to help the education system upgrade technical skills.

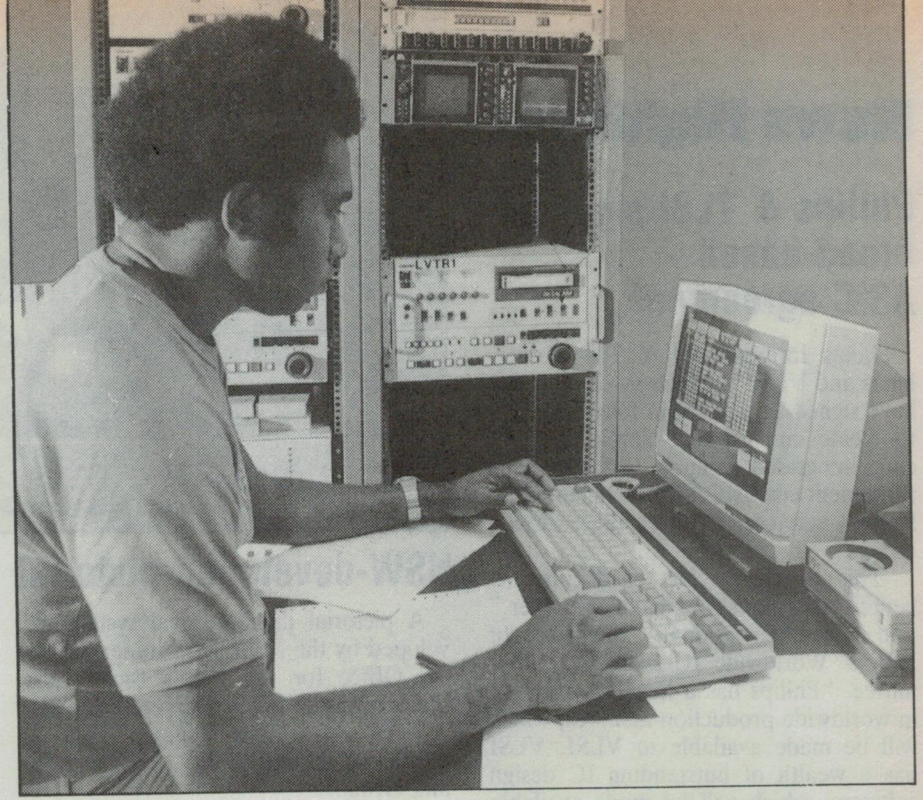
Although of commercial grade, the software has the advantage books used in the teaching of integrated circuit design. The authors of the introductory VLSI text are Dr. Douglas Pucknell and Dr. Kamran Eshraghian, both of the University of Adelaide and both of whom are founders of ISD. Thus the company has long had a corporate culture closely concerned with the need and desire to educate the future builders of the Australian electronics industry.

Both the products and services of Integrated Silicon Design are being offered to australian tertiary institutions at cut rate prices to entice them into taking advantage of the latest technology available. The range includes software products for designing integrated circuits and a fabrication service that will work to university needs in terms of timing and pricing. In this way a university can take advantage of the closely coupled teaching and software interface. Then actual fabrication of completed designs can be realised at a commercial foundry, to complete in every respect a students introduction to and practical application of the technology.

Toshiba to adopt Carver's "sonic holography"

Toshiba America and Carver Corporation are jointly developing Carver's "sonic holography" system, which Toshiba plans to incorporate into its larger sized stereo TV receivers.

The sonic holography system uses special signal processing circuits to cancel undesirable crosstalk between the two stereo sound channels, and is said to provide enhanced clarity, depth and stereo focussing. Toshiba is apparently planning to use the system in its new range of up-market 27" and 30" FST (flat square tube) sets, and also its 46" and 50" projection sets.



Bond Media instals videotape system in PNG

Bond Media has installed a LaKart II Videotape Program Presentation System at its EM TV Studio Centre at Boroko near Port Moresby in New Guinea.

The system is being used to integrate six standard Beta video tape transports with output switching via a Grass X LV/2A audio/video switcher.

Station Manager Gerry Thorley says that the LaKart II System has significantly improved the efficiency of EM TV's program presentation operations. The station is presently investigating the feasibility of extending the system to a second program output channel.

News Briefs

- US maker of solid state relays and I/O modules Continental Industries has appointed ***Amtex Electronics*** as its exclusive distributor in Australia.
- ***Wormald International (Aust)*** has been appointed exclusive agent in Australia for the Sonnenschein range of "Dryfit" sealed lead-acid secondary batteries.
- ***TDK (Australia)*** has moved to larger premises at 14/39 Herbert Street, St. Leonards 2065. The telephone number is (02) 437 5100, and fax number (02) 439 7151.
- The Barco range of high-quality video monitors is now being exclusively distributed in Australia by ***Quantum Pacific***, of Unit B, 5 Skyline Place, Frenchs Forest 2086. Phone (02) 975 1323.
- ***Total Electronics***, a unit of Email Limited, has moved to 15-17 Hume Street, Huntingdale, 3166. Phone (03) 544 8244, fax (03) 543 8179.
- David Jacobs, formerly with Sony Australia, has been appointed national sales manager for hi-fi distributor ***Scan Audio***. Ian Parnell has also been appointed NSW sales manager, and Ralph Grundl Vic sales representative.
- Major Taiwanese computer maker Acer Incorporated (formerly Multitech) has appointed two Australian distributors for its products. ***Dick Smith Electronics*** will continue to market the PC-compatible models (500+ and 710), while the "top end" models (910, 1100 and PS/2 compatibles) will be in future marketed by ***Remington***, the computer and office automation arm of Natcorp Investments.
- Richard Benfatto, formerly of AWA Microelectronics, has been appointed field sales engineer at ***Texas Instruments Australia***.
- US computer hardware maker Bit3 Computer Corporation of Minneapolis has appointed ***Mostyn Enterprises*** as its sole Australian agent. Mostyn is at 35 Alexander Street, Dundas NSW, phone (02) 871 6279.
- Gordon Jalkemo has been appointed general manager for ***Integral Fibre Systems*** (IFS), a member of the Andrew Sweeney Electronics Group.
- David Gradwell, formerly of Prime Computers, has been appointed national sales manager of Tektronix affiliate ***IDG***.

News Highlights

Philips & VLSI sign broad-based ASIC agreement

Philips International of The Netherlands and VLSI Technology of the USA have signed agreement in four key areas to create and produce application-specific integrated circuits (ASICs). The agreement covers CAD design software, foundry services, cell libraries, and gate arrays.

"This agreement lets each company benefit from the strengths of the other," said Cees Krijgsman, Chairman of Philips' Worldwide IC Executive Committee. "Philips has a heavy investment in worldwide production facilities, which will be made available to VLSI. VLSI has a wealth of outstanding IC design software, which will be made available to Philips."

"We are pleased that Philips, after extensive evaluation, selected our IC design software and gate array families, underscoring our belief in the quality and strength of these products," said Alfred J. Stein, VLSI's Chairman and Chief Executive Officer.

Under the terms of the agreement, VLSI will make its IC design software available to Philips for use in Philips' semiconductor operations. VLSI will also license its software to interested Philips customers, including Philips' user divisions. In addition, the agreement calls for Philips to provide foundry services for VLSI, with qualification beginning in the second half of 1988 for 1.5-micron technology.

VLSI will license all elements of its current 1.5-micron ASIC product libraries to Philips, and the companies will also exchange libraries for 1 micron and below on a reciprocal basis. Both parties are committed to design rule compatibility and the adoption of mutually agreed-upon interface formats to facilitate this exchange.

NSW-developed pictorial data retrieval system

A pictorial data retrieval system developed by the NSW Government Printing Office for the state's Bicentenary celebrations is to be marketed and developed by a new company set up jointly by the NSWGPO and the Infolink Group.

The videodisc-based system was initially developed by the NSWGPO to provide the public with immediate access to the enormous library of historical photographs, in this Bicentennial year. The initial database in the Bicentennial Archives Project is around 400,000 photographs. The new Videodisc Pictorial Retrieval System handles the efficient storage of images and associated descriptive text, as well as the ability to rapidly search files and retrieve online both images and text simultaneously.

As marketed by Search Tech, the system includes an analog optical disc containing the images and text, specialised software and a standalone microcomputer connected to a videodisc player. Two software packages are currently available, *Just Imagine* for professional access and *Imagex* for public access.

Electronics 88 exhibition/convention

From 4-6 October at the Adelaide Convention Centre, the Electronics Association of South Australia will present Electronics 88 – a conference and exhibition designed to illustrate recent and potential applications of electronic technology covering computing, communications and micro-electronics.

The exhibition will compliment the conference where topic areas for paper presentations and workshops will include Biomedical engineering, EFT/POS, automobile engine management, CAD/CAM, automated testing, devices, machine vision, process control, implanted devices, gallium arsenide, signal processing, digital/data communications, staellites, Viatel/Teletext, cellular radio, CD ROMS, remote sensing, security and broadcasting.

The exhibition will take up the entire Plenary Hall of the Adelaide Convention Centre.

For future information about the conference and exhibition contact Phillip Styles Exhibition Services, 4 Lovell Court, Clarence Gardens, South Australia 5039 or phone (08) 371 1700.

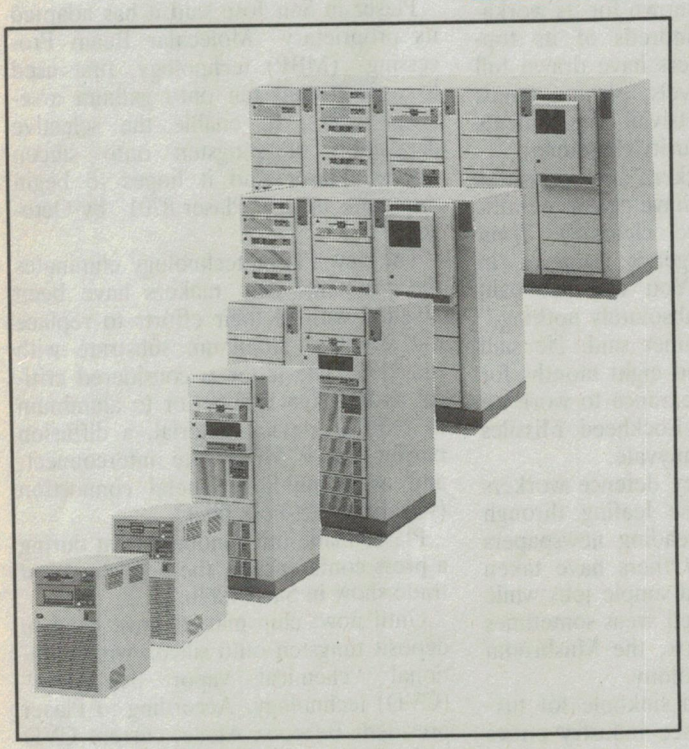
IBM releases new minicomputer range

A new family of mid-range computers designated the Application System/400 has been released by IBM. The new systems seem destined to ultimately replace existing System/36 and 38 machines.

The new systems are said to offer a 24-fold increase in memory capacity (up to 96Mb as standard), a 48-fold increase in mass storage (up to 27Gb) and a 10-fold increase in speed. They also boast a new operating system, OS/400, which offers software compatibility across the full range of models.

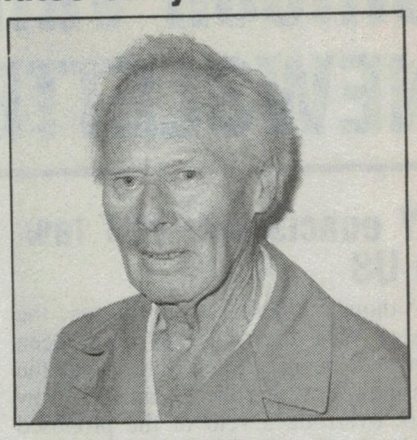
The AS/400 series use 48-bit addressing, which gives a potential memory capacity of 281 terrabytes. The largest system (B60) offers 1 second user response with 45,000 transactions per hour.

Other features of the new systems include "self training" applications software, remote on-line hardware fault diagnosis, the ability to upgrade systems and applications software from a remote location via a communications channel, and the use of IBM's densest memory card to date. The latter uses 1MB DRAM chips, and achieves 16 megabytes per card.



IBM spokespeople described the release of the new AS/400 series as "one of the five most important announcements that IBM has ever made". Systems prices range from around $65,000 to over $1 million.

Long-time reader donates early volumes



Regular readers of the magazine will know that we have been seeking copies of our predecessor publication *Wireless Weekly*, for the years 1922 – 1926. Our own reference copies have only covered the years from 1927 to the present day, leaving a sad gap.

We are therefore delighted to announce that we have now been presented with bound copies of Volumes 1 and 3 of *Wireless Weekly* thanks to the generosity of long-time reader of the magazine, Arthur Mead of Bexley NSW.

Mr Mead is 81 and has been reading the magazine ever since our first issue was published in August 1922 – surely a claim very few could make! He has also been an enthusiastic radio amateur since 1925, currently holding the callsign VK2JM.

An electrical field officer for Telecom over many years (when it was still called the Postmaster-General's Department), Mr Mead is a telephone mechanic and a licensed electrician. He was also very active in motorcycle racing for quite a few years, but says he doesn't have time to do this nowadays.

The volumes of *Wireless Weekly* presented to us by Mr Mead were originally the property of his late friend and fellow radio amateur, Bill Lewis VK2YB who passed away in 1976.

Our grateful thanks to both Arthur Mead and Bill Lewis for helping us to find an important part of the magazine's history. And if any other readers can help us find other missing copies or (dare we hope) volumes, our editor would be delighted to hear from you. EA

Silicon Valley NEWSLETTER . . .

NY enacts first VDT law in US

Although widespread in Europe, the use of VDT terminals has never been regulated in the United States until the legislature of Suffolk County in New York overrode a veto of the proposed bill by the County Executive.

The new law affects employers with more than 20 computer terminals and it pertains to any equipment purchased after January 1, 1980.

Under the new law, employers are required to pay for 80% of the cost of annual eye examinations and the cost of eye glasses that might be prescribed as a direct result of the use of VDTs. The law also stipulates that all VDT workstations must be "ergonomically sound," which will force business owners to purchase special adjustable chairs, tables, and desks, as well as install special lighting in VDT terminal areas.

VDT regulations such as the one adopted in Suffolk County are bitterly opposed by the business community. Still more than half of the states currently are considering the introduction, or have introduced legislation regulating the use of VDT-based equipment. Some states, including California, already have adopted voluntary or advisory guidelines for VDT use. But the Suffolk law is the first instance of a mandatory regulation.

AMD shoots for 0.35 micron technology

Advanced Micro Devices has announced details of its earlier plans for a new research facility. The Sunnyvale chip maker said it is now budgeting some $US100 million for the facility, which will be built on land AMD owns next to its Headquarters complex.

Earlier this year Intel revealed plans for a $95 million R&D lab in Santa Clara, and in April, National Semiconductor opened its $75 million Fairchild Research Centre at its headquarters site.

"Silicon Valley is alive and well," said AMD chairman Jerry Sanders, regarding the huge commitment the valley's biggest chip makers are making to advanced research in the valley.

According to Sanders, the facility will include a 35,000-square-foot super clean room. "This clean room will be 1000 times cleaner than our cleanest to date. A lot of the equipment that will go into it hasn't been invented yet," commented AMD spokesman John Greenagel.

Sanders vowed that research will focus on process technology and designs for components with 0.35 micron features, a size that is even smaller than the 0.5 micron goal set by Sematech, the chip industry's recently formed manufacturing reseach consortium.

Hundreds wait up to a year for security clearance

Silicon Valley is known for its workaholic style, but hundreds of its top-secret defence workers have drawn full pay for reading novels, playing tennis and working on trivial assignments while waiting for security clearances.

In interviews, workers and associates describe how they have spent months waiting for high-level clearances from military and intelligence agencies in Washington, DC. "You can get paid very well for doing absolutely nothing," a computer programmer said. He said he has already waited eight months for a "special access" clearance to work on a secret project at Lockheed Missiles and Space Co. in Sunnyvale.

Some Silicon Valley defence workers have passed the time leafing through company manuals, reading newspapers and playing sports. Others have taken classes and performed simple jobs while confined to unclassified areas sometimes known as the Ice Box, the Mushroom Patch or the Leper Colony.

By any name it's a sinkhole for taxpayer's money, defence industry critics say.

The General Accounting Office, an arm of Congress, estimated that defence contractors – and ultimately taxpayers – lost $US340 million in 1982 because of the time involved in clearing people at just the low end of the classified scale. A GAO investigator said the situation has improved, but proposed budget cuts might make things worse again.

Wolfgang Demisch, Wall Street defence industry securities analyst, said, "You hire somebody, and if as a kid he went to Eastern Europe on a bike, he's fired. But it takes six to nine months to find out, so in the interim you have him twiddling his thumbs. He's dead time for a year."

Valley start-up cracks the tungsten problem

In a development that could vastly increase the reliability of sub-micron components, a Silicon Valley equipment start-up announced the development of a new breakthrough process for depositing tungsten on silicon and gallium arsenide wafers.

Plaser in San Jose said it has adapted its proprietary "Molecular Beam Processing" (MBP) technology, first used to deposit tungsten onto gallium arsenide wafers, to enable the selective deposition of tungsten onto silicon wafers. Plaser said it hopes to begin shipments of the "Plaser 8701" by October.

The new Plaser technology eliminates the problems chip makers have been plagued with in their efforts to replace the standard aluminum substrate with tungsten. The latter is considered critical as tungsten is superior to aluminum as both a contact material, a diffusion barrier, as a MOS gate interconnect, and as a multilevel metal connection (via or contact-hole filler).

Plaser made the announcement during a press conference at the Semicon West trade show in San Mateo.

Until now, chip makers have tried to deposit tungsten onto silicon with traditional "chemical vapor deposition" (CVD) technology. According to Plaser president Behrooz Ataee, current CVD technology is inadequate for tungsten deposition as it brings along a host of problems, including non-uniformity of deposition, increased resistivity, encroachment, and "worm hole" where tungsten penetrates the substrate in

areas it isn't supposed to.

Instead of exposing the wafer to tungsten vapor that is randomly spread throughout the CVD chamber, Plaser's MBP technology introduces the reactive gases into the chamber in a uniform "beam-like" manner that is spread evenly across the breadth of the wafer, resulting in a uniform deposition in which the thickness at the edges of the circuit closely approaches the thickness at the center.

With the development of the MBP process, for which Plaser has already secured 72 patents worldwide, the company appears poised to quickly acquire a large share of the market for submicron CVD processing.

AEA forms HDTV taskforce

Following its day-long conference on US involvement in the future high-definition television market, the American Electronics Association has announced the formation of a special task force and charged it with helping US electronics firms get into this market – which is projected to grow as large as $US100 billion in worldwide sales by the turn of the century.

In all, 50 senior executives from leading American high-tech firms attended the conference in Santa Clara. Even NASA and President Reagan's Office of Science & Technology sent representatives to the event.

The message at the conference was clear, as the participants were told in no uncertain terms that failure of the US industry to participate in the HDTV business will cause the US to lose its ability to compete in other high-tech markets as well. This because the new generation of digital TVs will require major advances in key technologies, including semiconductors, signal processing, telecommunications, and display.

The participants agreed that the US should develop an ATV standard that is significantly different from those already developing in Japan and Europe.

TI makes composite Si/GaAs chip

Texas Instruments has announced the development of the world's first semiconductor featuring both silicon and gallium arsenide on the same chip.

TI officials said during a demonstration of the chip that the combination of silicon and gallium arsenide could lead to components that will be able to take advantage of the high speeds that can be achieved with gallium arsenide, while making these chips much stronger and thus easier to produce than Ga-As chips which are very brittle.

Also, silicon allows for much greater circuit density than gallium arsenide and has a much lower power requirement.

But the TI officials cautioned that despite being able to demonstrate the feasibility of the combination of the two key materials, it would probably be several more years before the technology can find its way from the lab into commercial production applications.

Putting silicon and gallium arsenide together into one chip was not a simple task, the TI researcher said. During the first phase of the process, a wafer made of only silicon is fabricated, after which gallium arsenide is "grown" on the surface in tiny islands in preselected spots.

IBM leapfrogs industry into 8-inch wafers

Just when it appeared that any trend towards 8″ wafers was all but dead for the time being, IBM stunned many semiconductor manufacturers with the announcement that it has put an 8″ wafer fab into production and is using the Essex Junction (Virginia) facility to produce the firm's 1 megabit DRAM chips.

IBM made the announcement during the Semicon West trade show recently in San Mateo. It caught many in the industry by surprise, as the evolution from 4″ and 5″ wafers to the new 6″ capacity is still in full swing.

IBM however, has not built any 6″ wafer fabs and has apparently decided to leapfrog right on to the 8″ wafers, which can produce up to 450 1-megabit chips per platter – three times as many chips as can be printed onto IBM's current 5″ wafers.

For many semiconductor manufacturers, the announcement could spell trouble. A commitment to 8″ wafers by IBM may well be interpreted as the setting of a new industry standard, as IBM is the world's largest producer of semiconductors.

Companies that have invested tens of millions of dollars during the past three years into new 6″ facilities may find themselves forced to change to the 8″ capacity much earlier than they had anticipated. Such a costly move would take away considerable resources they may have planned to devote to product and process research and development. EA

The Serviceman

New and familiar problems with old sets

I had a real blast from the past this month, with a job that took me back twenty years to olde worlde valve circuitry. At the same time it hit me with a problem that's just as common with modern solid state equipment. It's very easy to be misled by your test gear, if you're not extremely careful.

I was asked by a customer to repair an old HMV M7 monochrome TV, a valve type set dating from the early sixties. I did my best to convince him that the set wasn't worth fixing, and that my bill would be more than the set was worth.

He was very persistent though, and kept insisting that "it was only a resistor." It's usual to hear customers insisting that it's "only the picture valve", so "only a resistor" seemed to be an easier job and one more worth doing.

In detail, this set was showing a very dark picture which took about half an hour to struggle onto the screen. Now, even without seeing the set, I would be prepared to bet that it had a dud tube. And so it turned out to be. When I put the tester on it, the tube showed not the slightest sign of emission and it is still a puzzle to me that it could show any kind of picture at all.

I told the owner that no resistor on earth could repair that set, and that he would be best served by dumping it on the nearest tip. But he would not be convinced, and kept insisting that a similar fault five years ago only required a resistor to fix. He even pointed out to me the particular resistor involved.

Nothing I could do or say would convince him that his set needed more than one resistor, so to humour him I replaced it. I think he suspected me of fitting a dud one because there was absolutely no improvement in his picture. Try as I might, I couldn't convince him that only replacing the picture tube would cure his set.

Eventually, I had to pack up my tools, push past him to the door and take my leave. As I drove away I made a fervent wish that I would never see that set again. But my wish was not to be granted.

Next day, the customer was back to ask me if I would try to get a replacement picture tube for his old set. He was desperate to have it working again and was prepared to mortgage his pension to pay for the job. I must admit, I felt a bit sorry for him, yet I wondered why he didn't invest the cost of this job in a newer, second hand colour set. Still, it was his set and his money, so who was I to argue?

When I got the set back to the workshop and had a good look at the picture tube, I began to think that the customer might have got a bit lucky.

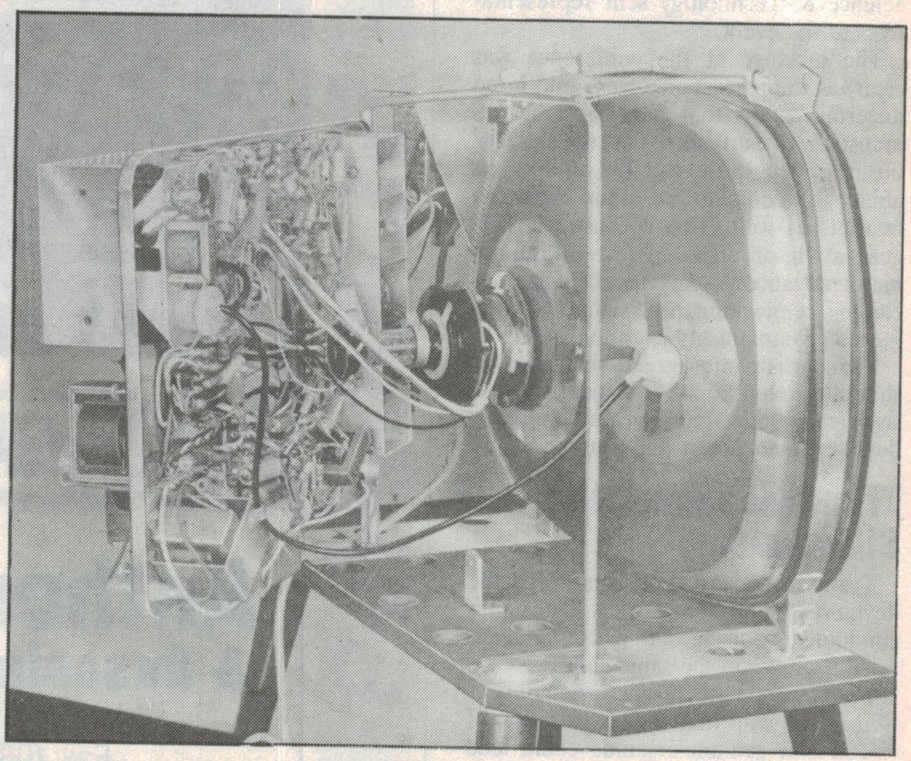
Some ten or twelve years ago, a local wholesaler had closed his business and I had bought his stock of regunned black and white picture tubes at very low prices. Some of them had been sold off at the time, and the rest stowed away under the house and almost forgotten.

Among them was a tube similar to that in the old HMV, still sealed in its original carton, with its twelve month warranty card – and still giving a 100% emission reading!

It took me some time to locate the old B&W picture tube replacement charts, but when I did I realised just how lucky my customer had become. The new tube was not merely a suitable replacement, it was THE recommended replacement for the old one.

To make matters even better, tube replacement in this set could not have been easier. First the cabinet back and the control knobs are removed, then six screws around the base board and two short bolts above the picture tube. After this, the whole cabinet can be lifted off, leaving the tube and chassis sitting naked on the baseboard.

The tube was held in place by a stout rim band, secured by heavy screws at the top and bottom. Loosening these screws allowed the old tube to be lifted



Picture tube replacement was very easy with the early HMV monochrome sets – the cabinet lifted off, and the chassis swung back.

away from the chassis and the new one fitted just as easily. Fifteen minutes and the job was done. (And there were no problems with the convergence, either!)

Unfortunately, when I fired the set up I got a brilliant screen, but no picture. The sound was OK, although a little weak. But if there was any picture, I certainly couldn't see it.

I turned the brightness down and was rewarded with a very faint picture – enough to be recognisable, but quite unsatisfactory for comfortable viewing.

An oscilloscope check at the picture tube base showed that there was only 3V peak to peak of video signal, where there should have been 60 odd volts. And so began a long and frustrating hunt for the reason for the weak video.

The trouble with this set was that it used valves instead of transistors – and I haven't worked with valves for ten years or more. One tends to lose track of old technology when it is not in use day after day. I had to get out my old valve manuals to read up about voltages and currents, in order to make sense of the readings I was getting around this chassis.

An unfortunate aspect of the set was that I couldn't get at the valve bases for measurement while the set was turned on. The chassis could only be swung out far enough for service after the yoke plug and its B+ link had been removed.

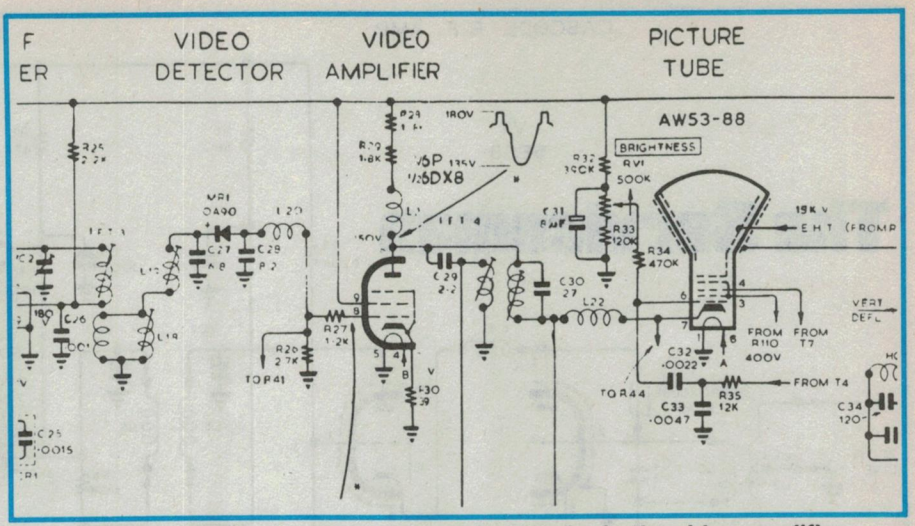
So all I could do when the chassis was open was to measure various resistances to either ground or B+. When the chassis was restored and switched on, I could remove the valves and check for voltage at the top of the sockets. But it was difficult, almost impossible, to take any meaningful measurements while the set was working.

Then I remembered a dinkus I had made up twenty years ago for just this purpose. It consisted of a valve socket soldered on the top of a matching plug. The socket pins were splayed outwards to allow access for measurement while the valve was plugged in and working.

I finally found the device in a box of assorted small tools, and soon had most of the measurements that I needed. The set was developing no AGC voltage, which wasn't surprising. But all the anode, screen and cathode voltages that I could get at were about normal.

It wasn't possible to get readings from the valves in the tuner, because they were mounted upside down with deep screening skirts around them. All I could do was to pull the valves and poke a meter probe into the socket to chek for voltages.

Everything seemed to be in order, yet



One problem with the old HMV set turned out to be in the video amplifier stage, shown here.

the chassis wasn't doing anything useful with any of the signals I applied. Not even a couple of millivolts applied direct to the tuner antenna terminals could produce any more than a dark, murky picture that disappeared as soon as the brightness was advanced above very dim.

I persevered with resistance measurements in all the old familiar places, and some that were not so familiar. I checked everything I could lay hands (or a meter probe) on. I found a number of the old cracked carbon resistors had gone high, and replaced them with modern metal film types, but all to no avail. There was still no worthwhile picture.

At this point I had to abandon the scientific approach and go in for a more suck-it-and-see type of servicing. Another piece of my useful home made test gear was then pressed into service. This is a small 5" National portable TV, that has been extensively modified.

Among other things, the IF lead from the tuner to the IF strip has been broken and brought out to two RCA sockets in the bottom of the cabinet. In normal use a U-shaped link joins the two sockets, but the link can be removed and the tuner output fed through a suitable lead to another set. Or the output of a suspect tuner can be fed into the test set through the IF input socket.

In this case, I fed the National tuner into the IF amplifier of the old HMV and got a passing-fair picture. It was still lacking good contrast, but at least it was brighter than the earlier effort.

Next, I fed the output of the HMV into the little set – and got a very poor picture as a result. It seemed that I had at least two faults in the big set, one in the tuner and the other in either the IF strip or the video amplifier.

I decided to get the tuner working properly first. One good thing about old valve tuners is that they are big and robust and pretty easy to work on. First, I pulled out the channel "biscuits" and checked them for damage or dry joints. Then I cleaned and retensioned the spring contacts.

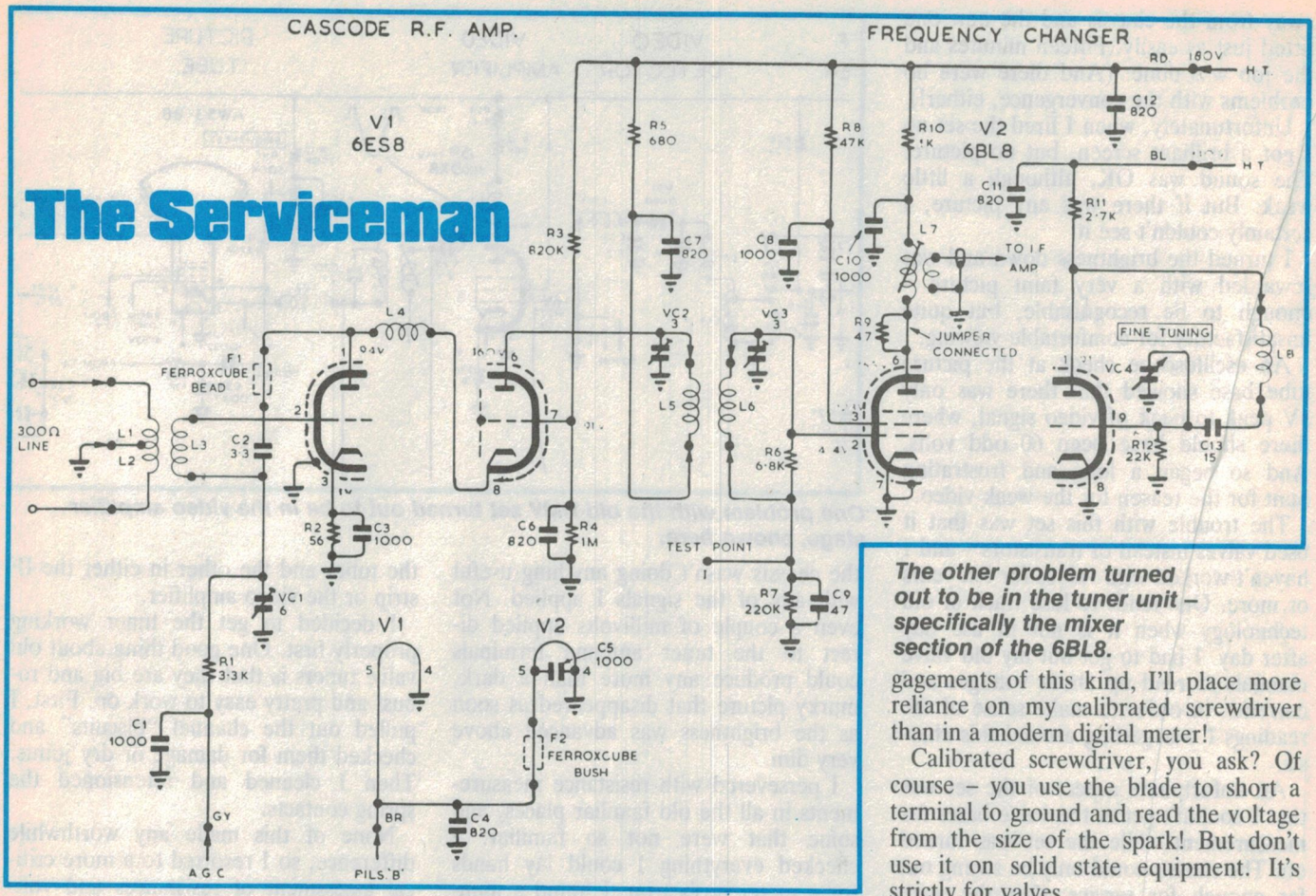
None of this made any worthwhile difference, so I resorted to a more critical assessment of resistances and voltages around the tuner. With the valves out of their sockets, I got readings of HT voltage (180V) at the anode and screen of the converter valve and at the top anode of the RF amplifier valve.

The 6ES8 RF amplifier in this set is run in cascode, where the second anode gets its B+ voltage from the cathode of the top triode. With the valve out of the socket, there can be no voltage – so a resistance check is the only way to make sense of the system.

I checked for continuity from all the external terminals to the various socket pins and found that most of them were very close to the values given in the service manual. But when I came to the feed resistor to the converter screen (R8), it was quite a different story.

Instead of the expected 47k ohms between the 180V terminal on the tuner body and pin 3 in the 6BL8 socket, I found a resistance of some 18 megohms, as read on my modern digital multimeter. And that was it! The resistor was as good as open circuit.

This is yet another example of confusing readings caused by the high impedance of a digital meter. I rechecked the voltage at pin 3 again, first with the digital meter, then with an old analog meter. The digimeter read 178 volts, the



The other problem turned out to be in the tuner unit – specifically the mixer section of the 6BL8.

analog meter – 0 volts. In this case there was a very high resistance for the digital meter to read through, but I have known them to read voltage on a particular terminal through an impedance that is to all intents and purposes open circuit!

Getting the rotor out of the tuner was a bit fiddly, but I managed and soon had a new resistor in place of the faulty one. With everything back in place, I switched on and was rewarded with quite a good picture. Still a bit darker than one would expect from a new tube, but far better than anything I'd had up to this point.

All that remained was to get the brightness up, and for this my little socket doohicky was invaluable. With the video output valve sitting on the test socket, I was able to determine that a good two volts peak to peak of video was being supplied to the grid of the 6DX8. At its anode there was something over 80 volts of video, considerably more than was called for by the circuit diagram.

The only problem that I could see was that the anode voltage of the video amplifier was a bit higher than specified. This could have been caused by higher than normal resistance in either the anode or cathode circuits.

The anode resistance was spot on, but the cathode was higher than the manual said it should be, 100 ohms instead of 39 ohms. I hooked a 68 ohm resistor across from the cathode pin to earth and the picture suddenly sprang to life, with brilliant highlights and a good, rich contrast. Indeed, the picture was as good as new.

When I swung the chassis out to replace the faulty resistor, I was surprised to find that it was in fact a 100 ohm unit. It had been in the set since new and had not changed its value. Yet the set clearly needed a 39 ohm resistor to work properly. I don't know how or why, but fitting the correct value resistor has restored the set to perfect operation.

So the customer was nearly right when he told me the trouble was "only a resistor." It was "only two resistors" (plus a picture tube, of course), although neither of the resistors was the one he pointed out.

He has no idea of how much work I put into repairing his antique. If I charged him the full bit, it would buy him a new colour set. But in a perverse sort of way, I have enjoyed my reunion with the old technology. In future engagements of this kind, I'll place more reliance on my calibrated screwdriver than in a modern digital meter!

Calibrated screwdriver, you ask? Of course – you use the blade to short a terminal to ground and read the voltage from the size of the spark! But don't use it on solid state equipment. It's strictly for valves.

I've also heard of one technician who uses a calibrated finger. He only recognises three voltages – "Yep, it's on!", "Ouch!", and "Bloody Hell!!"

Finally this month, a follow-on from my story in the April issue, about the Rank C2205 with very odd symptoms.

Remember the story where the owner used the volume control to adjust the picture?

I said then that I was looking forward to seeing more of those sets, so that I could check just what symptoms appeared in the chassis under other circumstances. Well, several such sets have come in since, and they all experience queer symptoms when C351 is either faulty or removed experimentally. There is a family resemblance to all the symptoms, but there are still big differences between them.

In one set, for instance, removal of the cap showed that channel 6 was perfectly normal over most of the volume control range, although the horizontal sync became unstable at the very lowest setting.

Channel 2, on the other hand, could only be seen with the volume control at either the very bottom or the very top of its range. At every other setting the fine tuning pulled the set right off chan-

nel – not even the sound was audible. And finally, when switched off, the set gave out with the loudest, rudest Bronx Cheer you've ever heard.

Another Rank, this time with a faulty C351, had yet another set of symptoms. This one had weak sound without distortion, but the sound crackled when the volume control reached the bottom of its travel. A secondary symptom was intermittent total loss of horizontal hold.

There was a moderate herringbone pattern on both channels at the higher volume levels, but the owner claimed never to have noticed this until I pointed it out. It was the horizontal problem that most worried him.

When the faulty cap was removed, but before the new one was fitted, the only other symptom was a squeaky blurt when the set was turned off. A new capacitor produced loud sound, cleared the other symptoms and gave a new life to the old set. (It had been threatened with the "Tip"!)

Quite obviously, C351 is responsible for the bulk of these odd symptoms. However the state of other electros on the 19V rail is a factor in determining the variety and severity of the various symptoms. Who knows? It might just be possible to pinpoint faulty caps by a careful analysis of the secondary symptoms when C351 is removed from circuit!

I have been repairing these Ranks for a good many years, yet it was only a few months ago that I first came across this C351 fault. Since then I have had the same fault in three more sets. How do the electro makers arrange for their products to last exactly 11 years and three months?

TETIA Fault of the Month

Philips CP510 (KT3A-2 chassis)

Symptom: Intermittent but regular vertical collapse to narrow line at centre screen. Rather like a hiccupping vertical stage.

Cure: Q520 (BD233) output transistor breaking down. This fault is heat sensitive and can be tested for with freezer spray. Freezing the transistor will hold off the fault for several minutes.

This information is supplied by courtesy of the Tasmanian branch of The Electronic Technicians' Institute of Australia. Contributions should be sent to J. Lawler, 16 Adina St, Geilston Bay, Tas 7015.

METEX 3800 MULTIMETER

This instrument is a compact, rugged, battery operated, hand held 3 1/2 digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, for testing Audible continuity and transistor hFE. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features...
- Push-button ON/OFF power switch.
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- 1/2" high contrast LCD.
- Automatic over-range indication with the "1" displayed.
- Automatic polarity indication on DC ranges.
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001".
- High Surge Voltage protection 1.5 KV-3 KV.
- Diode testing with 1 mA fixed current.
- Audible Continuity Test.
- Transistor hFE Test.

SPECIFICATIONS

Maximum Display: 1999 counts 3 1/2 digit type with automatic polarity indication.
Indication Method: LCD display.
Measuring Method: Dual-slope in A-D converter system.
Over-range Indication: "1" Figure only in the display.
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat.Q91530 ..... **Normally $109**
SPECIAL $79

METEX 3530 MULTIMETER

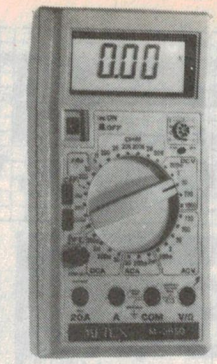
This instrument is a compact, rugged, battery operated, hand held 3 1/2 digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, Capacitance, Transistor hFE and Continuity Test. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features...
- Push-button ON/OFF power switch.
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- 1/2" high contrast LCD.
- Automatic over-range indication with the "1" displayed.
- Automatic polarity indication on DC ranges.
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001".
- High Surge Voltage protection 1.5 KV-3 KV.
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current.
- Audible Continuity Test.
- Transistor hFE Test.

SPECIFICATIONS

Maximum Display: 1999 counts 3 1/2 digit type with automatic polarity indication.
Indication Method: LCD display.
Measuring Method: Dual-slope in A-D converter system.
Over-range Indication: "1" Figure only in the display.
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 ..... **Normally $139**
SPECIAL $109



METEX M-3650 MULTIMETER

20A, 3 1/2 digit frequency counter multimeter with capacitance meter and transistor tester.

This spectacular, rugged and compact DMM has a bright yellow high impact plastic case. It features a frequency counter (to 200kHz), diode and transistor test, continuity (with buzzer), capacitance meter, up to 20 amp current measurement and comprehensive AC/DC voltage, current and resistance ranges.

CHECK THESE FEATURES....
- Push-button ON/OFF switch.
- Audible continuity test
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- Transistor test
- Diode test
- Quality probes
- 1/2" High contrast LCD.
- Full overload protection
- 20 Amp
- Built in tilting bail
- Capacitance meter
- Instruction manual

Q91550 .... Normally $165
Special, only $129

METEX 4500H MULTIMETER

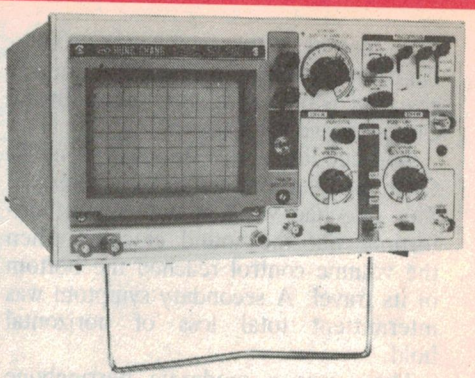
10A, 4 1/2 digit multimeter with digital hold, transistor tester and audible continuity tester.

The Metex 4500H is perfect for the technician, engineer or enthusiast who requires the higher accuracy of a 4 1/2 digit multimeter. This meter is exceptionally accurate, (just look at the specifications), and yet, still retains an exceptionally low price!

The Metex 4500H features digital hold which is normally only found on very expensive multimeters. This enables you take a reading and hold that reading on display even after you have removed the probes, simply by pressing the hold button.

CHECK THESE FEATURES...
- Readout hold
- Transistor Tester
- 4 1/2 digit x 1/2"(H) LCD
- Audible continuity tester
- Push-button ON/OFF switch.
- Quality set of probes
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- Built in tilting bail.
- Instruction manual
- Full overload protection
- hFE test
- Battery and Spare fuse
- Diode Tester
- Vinyl case

Q91560 .... Normally $175
Special, only $159



HUNG CHANG (RITRON) 20 MHz DUAL TRACE OSCILLOSCOPE

- **Wide bandwidth and high sensitivity**
- **Internal graticule rectangular bright CRT**
- **Built in component tester**
- **Front panel trace rotater**
- **TV video sync filter**
- **Z axis (Intensity modulation)**
- **High sensitivity X-Y mode**
- **Very low power consumption**
- **Regulated power supply circuit**

COMPONENT TESTER is the special circuit with which a single component or components in circuit can be easily tested. The display shows faults of components, size of a component value, and characteristics of components. This feature is ideal to troubleshoot solid state circuits and components with no circuit power. Testing signal (AC Max 2 mA) is supplied from the COMPONENT TEST IN terminal and the result of the test is fed back to the scope through the same test lead wire at the same time.

CRT

CRT: 6" (150mm) Flat-faced high brightness CRT with Internal Graticule.
Effective display area: 8 x 10 div (1 div = 10 mm)
Acceleration potential: 2KV

VERTICAL

Operating Modes: CH-A, CH-B, DUAL, ADD (CH-B can be inverted.)
Dual modes: Alter: 0.2ufs - 0.5ms/div. Chop: 1ms - 0.5s/div.
CHOP frequency 200KHz approximately.
Deflection factor: 5mV/div 20V/div +/- 3%. 12 ranges in 1-2-5 step with fine control.
Bandwidth: DC: DC - 20MHz (-3dB). AC: 10Hz - 20MHz -3dB).
Rise Time: Less than 17ns.
Overshoot: Less than 3%.
Input Impedance: 1M ohm +/-5%, 20pF +/-3pF
Maximum Input Voltage: 600Vp-p or 300V (DC+AC Peak).
Channel Isolation: Better than 60 dB at 1KHz.

HORIZONTAL

Sweep Modes: NORMAL, and AUTO
Time Base: 0.2ufs - 0.5s/div +/-3%. 20 ranges in 1-2-5 step with fine control.
Sweep Magnifier: 5 times (5X MAG).
Linearity: 3%.

TRIGGERING

Sensitivity: INTERNAL: 1 div or better for 20Hz - 20MHz (Triggerable to more than 30MHz). EXTERNAL: 1Vp-p or better for DC - 20MHz (Triggerable to more than 30MHz)
Source: INT, CH-A, CH-B, LINE and EXT.
Slope: Positive and Negative, continuosly variable with level control PULL AUTO for free-run.
Coupling: AC, HF-REJ and TV. TV SYNC Vertical and Horizontal Sync Separator Circuitry allows any portion of complex TV video waveform to be synchronized and expanded for viewing TV-H (Line) and TV-V (Frame) are switched automatically by SWEEP TIME/DIV switch.
TV-V:0.5s/div to 0.1ms/div. TV-H:50ufs/div to 0.2ufs/div.

X-Y OPERATIONS

X-Y Operations: CH-A: Y axis. CH-B: X axis Highest Sensitivity: 5mV/div.

COMPONENT TESTER

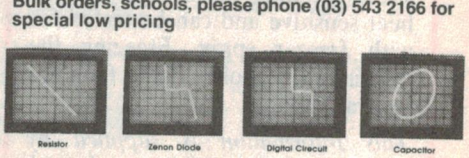
Component Tester: Max AC 9V at the terminal with no load. Max current 2mA when the terminal is shorted. (Internal resistance is 4.7K ohm)

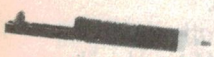
OTHER SPECIFICATIONS

Intensity Modulation: TTL LEVEL (3Vp-p); Positive ..... brighter.
BANDWIDTH: DC - 1MHz MAXIMUM INPUT VOLTAGE: 50V (DC+AC Peak)
Calibration Voltage: 0.5Vp-p +/-5%, 1KHz +/-5% Square wave.
Trace Rotation: Electrically adjustable on the front panel.
Power Requirements: AC, 100, 120, 220, 240V 20W
Weight: 7kg approximately.
Size: 162(H) x 294(W) x 352(D)mm.

Cat. Q12105 ..... **only $895**
(tax exempt only $775)

Bulk orders, schools, please phone (03) 543 2166 for special low pricing





ECONOMY SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11271 ..... **$11.95**

ECONOMY ANTISTATIC SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11281 ..... **$13.95**

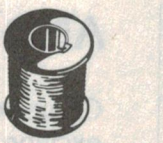
DESOLDERING BRAID

1.5 metres at direct import prices!

Cat.No.	1-9	10+
T11230	$1.75	$1.50

POWERFULL MINI DRILL

Featuring a powerful 6000 r.p.m. motor, this lightweight (113gm) drill is ideal for many jobs. Perfect for PCB work! Has a 0.8 to 1.2mm chuck and 1mm drill bit.
Requires 12V 1 AMP.(use with M19010)
Cat. T12302 ..... **$19.95**



SOLDER ROLLS

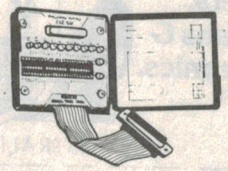
Absolutely top quality, unlike our opposition's!
60/40 Resin cored.

Cat.No.	Description	Price
T31000	.71mm 250gm	$8.95
T31002	.71mm 500gm	$15.95
T31010	.91mm 250gm	$7.95
T31012	.91mm 500gm	$14.95
T31020	1.6mm 250gm	$7.50
T31022	1.6mm 500gm	$13.95
T31030	.71mm 1 metre	$1.50
T31032	.91mm 1 metre	$1.25
T31034	1.6mm 1 metre	$1.00

RS232 FAST CABLER

Makes RS232 interface configurating fast and simple. 3 slide switches enable line swapping functions, positive and negative voltages are displayed on 6 tricolour LED's.

SPECIFICATIONS:
Connector: DB25 plug on 100mm cable and DB25 socket on 100mm cable.
Indicators: Tricolour LED's for pins 2(TD), 3(RD), 4(RTS), 5(CTS), 6(DSR), 20(DTR).
Switches: 3 Slide switches to swap loads.
Power: Interface power.
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm
X15710 ..... **$145**



RS232 BREAK OUT BOX

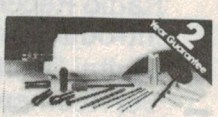
A simple way of monitoring RS232 interface lead activity. Interface powered, pocket size for circuit testing, monitoring and patching. 10 signal powered LED's and 2 spares. 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions.

SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket.
Indicators: Tricolour LED's for TD, RD, RTS, CTS, DSR, CD, TC, RC, DTR, (E)TC.
Jumper Wires: 20 tinned end pieces.
Power: Interface power.
Enclosure: Black, high impact plastic.
Dimensions: 85 x 95 x 30mm
X15700 ..... **$94.95**

PORTASOL PROFESSIONAL

- Four tools in one: Blow Torch, Hot Blow, Hot Knife
- No Cords or batteries
- Heavy duty, tip temperature adjustable up to 400°C.
- Equivalent to 10-60 watts
- Hard working. Average continuous use 90 minuters
- Refills in seconds
- Powered by standard butane gas lighter fuel
- Range of easily replaceable screw tips included
- Includes metal stand for the soldering iron when working
- Cap features built-in flint for igniting Portasol tip
- Includes snap case for storage

Cat. T12639 ..... **$89.95**



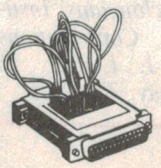
ARLEC SUPER TOOL

A versatile 12V electric tool for...
- Sanding
- Engraving
- Grinding
- Polishing
- Cutting
- Drilling
- Milling
- Erasing, etc.

Features:
Operates on safe, low 12 volts from mains electricity via AC adaptor (supplied). Light and easy to handle with touch switch and lock for continuous running. High torque motor. 10,000 R.P.M. Can drill 2mm holes in steel. 2 year guarantee

Contents:
- 12V Super Tool
- Plugpack AC adaptor
- 1 spherical milling cutter
- 1 wire brush
- 1 grinding wheel
- 4 drill bits, 0.6, 0.8, 1.0, 1.2mm
- Set of 5 chuck collets
- 6 eraser sticks
- Instruction sheets

Cat. T12300 ..... **$64.95**



RS232 WIRING ADAPTOR BOX

- Male to female
- 25 Detachable plug on leads
- 2 mini jumpers
- Ideal for experimenting or temporary connections

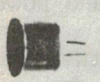
Cat. X15665 ..... **Normally $49.95**
Only $44.95

COMPONENTS GALORE!

ULTRASONIC TRANSDUCERS

Designed to transmit at 40kHz (L19990) and receive at 40kHz (L19991) with up to 20V I/P on the transmitter. These units can't be heard and so are ideal for TV remote controls, water level detectors, burgalar alarms, motion detectors and information carriers as they can be either pulsed or used in the continuous wave mode.
Full specifications below for design purposes.
Maximum Input Voltage: 20V rms
Centre Frequency (kHz): 40 + – 1.0
Sound Pressure Level 10V RMS: 110dB min.
Sensitivity (dB/v/ubar) min.: –65 min.
Bandwidth (kHz):
Transmit: 4.0 (at 100dB)
Receiver: 5.0 (at – 73dB)
Impedance:
Transmit: 500
Receiver: 5000

Cat. L19990 (Transmitter) **$6.95**
Cat. L19991 (Receiver) **$6.95**

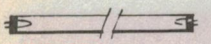


ELECTRET MIC INSERTS

With pins for easy board insertion.
Cat. C10170

1-9	10+	100+
$1.20	$1.00	$0.90

THIS MONTH ONLY!



U.V. TUBES

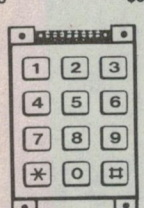
Fits into standard 15W flouro holder. Suitable for Scotchcal, Eprom erasing etc. As used in ETI Eprom Erasing Kit.
WARNING: Do not look directly into UV Tubes.
Cat. H28600 ..... **$29.95***
*If ordering by mail please include an extra $2 for "special" packing.

10 TURN WIRE WOUND POTENTIOMETER

Spectrol Model 534
¼" shaft.
Equiv (Bourns 3540S, Beckman 7256)
Dials to suit 16-1-11, 18-1-11, 21-1-11.

R14050	50R	R14100	5K
R14055	100R	R14110	10K
R14060	200R	R14120	20K
R14070	500R	R14130	50K
R14080	1K	R14140	100K
R14090	2K		

1-9	10+
$9.95	$9.50



NUMERIC KEYPAD

Unencoded keypad, 10 digit keys plus two utility keys. Light grey in colour.
OUTPUT ARRANGEMENT:

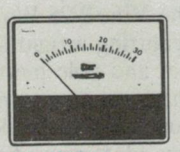
Output Pin N°	Symbol
1	N.A
2	Shield plate
3	Column 2
4	Row 4
5	Column 3
6	Row 1
7	Column 1
8	Row 2
9	Row 3
10	N.A.

Cat. C19030

1-9	10+	100+
$2.95	$2.50	$1.95

ECONOMY TRANSFORMERS

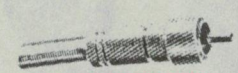
	1-9	10+
2155 240V 6-15V 1A Cat. M12155	$9.95	$8.95
2156 240V 6-15V 2A Cat. M12156	$14.95	$13.95
2840 240V 9V CT Cat. M12840	$5.95	$4.95
2851 240V 12-6V CT 150mA Cat. M12851	$5.95	$5.50
2860 240V 15V CT 250mA Cat. M12860	$5.95	$4.95
6672 240V 15-30V 1A tapped Cat. M16672	$14.95	$13.95



PANEL METERS GALORE!

We have a great range of panel meters at great prices!

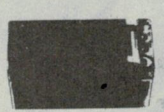
Cat.No.	Description	Price
Q10500	MU45 0-1mA	12.50
Q10502	MU45 50-0/50uA	12.50
Q10504	MU45 0-100uA	12.50
Q10510	MU45 0-5A	12.50
Q10518	MU45 0-1A	12.50
Q10520	MU45 0-1A	12.50
Q10525	MU45 0-20V	12.50
Q10530	MU52E 0-1A	14.50
Q10533	MU52E 0-5A	14.50
Q10535	MU45 VU PMetre	14.95
Q10538	MU65 0-50uA	16.95
Q10540	MU65 0-1mA	16.95
Q10550	MU65 0-100uA	16.95
Q10560	MU65 0-20V	16.95



RCA GOLD PLATED PLUGS AND SOCKETS

For those who need the ultimate in connection. Essential for laser disc players to get that fantastic sound quality.

Plug Cat. P10151	$2.95
Socket Cat. P10150	$2.25



RECHARGEABLE 12V 1·2AH GELL BATTERY

Leakproof, long service life batteries ideal for security systems, emergency lighting or as a computer backup power supply, etc.

Cat. S15029 ..... **Normally $19.95**

1-9	10+
$13.95	$12.95

CHROME LED BEZELS

9mm hole, available 3 colours

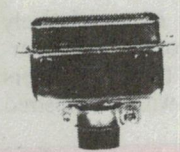
Cat.No.	Description	Price
S14030	Red	$1.20
S14032	Green	$1.45
S14034	Yellow	$1.45

KEY SWITCHES

Cat. S12500 ..... Normally $7.95		
1-9	10+	25+
$4.95ea	$4.25ea	$3.95ea

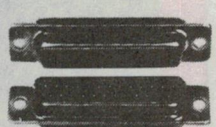
SPECTROL 64Y MULTI TURN TRIMPOTS

Cat.No.	Description	1-9	10+
R14700	10R	$3.50	$3.20
R14710	20R	$3.50	$3.20
R14720	50R	$3.50	$3.20
R14730	100R	$3.50	$3.20
R14740	200R	$3.50	$3.20
R14750	500R	$3.50	$3.20
R14760	1K	$3.50	$3.20
R14770	2K	$3.50	$3.20
R14780	5K	$3.50	$3.20
R14790	10K	$3.50	$3.20
R14800	20K	$3.50	$3.20
R14810	50K	$3.50	$3.20
R14820	100K	$3.50	$3.20
R14830	200K	$3.50	$3.20
R14840	500K	$3.50	$3.20
R14850	1M	$3.50	$3.20



CENTRONICS SOLDER PLUGS SPECIALS!

1-9	10+	100+
$2.95	$2.50	$1.95



DB25 CONNECTOR SPECIALS!

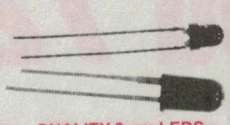
TYPE	1-9	10+	100+
9P	$0.70	$0.60	$0.50
9S	$0.70	$0.60	$0.50
9C	$0.60	$0.50	$0.40
15P	$0.70	$0.65	$0.60
15S	$0.70	$0.65	$0.60
15C	$0.70	$0.60	$0.50
25P	$0.70	$0.60	$0.50
25S	$0.75	$0.65	$0.60
25C	$0.70	$0.60	$0.50

DB 25 CRIMP SPECIALS!

Type	1-9	10+	100+
Female	$2.95	$2.50	$1.95
Male....	$2.95	$2.50	$1.95

TAG TANTALUM CAPACITORS SPECIALS!

Cat.No.	Description	Price
R16124	16V 4.7uF	$0.48
R16125	16V 10uF	$0.52
R16126	16V 15uF	$0.75
R16128	16V 22uF	$0.85
R16216	25V 2.2uF	$0.40
R16220	25V 4.7uF	$0.70
R16222	25V 6.8uF	$0.70
R16224	25V 10uF	$0.60
R16228	25V 22uF	$2.40
R16300	35V 0.1uF	$0.30
R16302	35V 0.15uF	$0.30
R16304	35V 0.22uF	$0.30
R16306	35V 0.33uF	$0.30
R16308	35V 0.47uF	$0.30
R16310	35V 0.68uF	$0.35
R16311	35V 0.82uF	$0.35
R16312	35V 1.0uF	$0.30
R16314	35V 1.5uF	$0.50
R16316	35V 2.2uF	$0.50
R16318	35V 3.3uF	$0.35
R16320	35V 4.7uF	$0.70
R16322	35V 6.8uF	$0.80
R16324	35V 10uF	$0.80
R16326	35V 15uF	$1.40
R16328	35V 22uF	$3.50

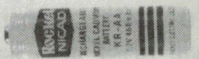


QUALITY 3mm LEDS

Cat. No. Col.	1-9	10+	100+
Z10140 Red	$0.15	$0.12	$0.10
Z10141 Grn	$0.20	$0.15	$0.12
Z10143 Ylw	$0.20	$0.15	$0.12
Z10145 Ora	$0.20	$0.15	$0.12

QUALITY 5mm LEDS

Cat. No. Col.	1-9	10+	100+
Z10150 Red	$0.08	$0.07	$0.06
Z10151 Grn	$0.15	$0.12	$0.10
Z10152 Ylw	$0.15	$0.12	$0.10



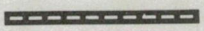
NICADS!

Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

Size	Desc.	1-9	10+	100+
AA	450 mA.H.	$2.95	$2.75	$2.50
C	1.2 A.H.	$9.95	$9.50	$8.95
D	1.2 A.H.	$9.95	$9.50	$8.95

RELAYS

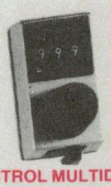
1-9	10+	100+	
S.P.D.T. 3A connectors.....			S14060
$1.50	$1.30	$1.10	
D.P.D.T. 3A connectors.....			S14061
$1.95	$1.75	$1.30	
S.P.D.T. 12V Coil 10A 240V			S14114
$4.95	$3.95	$3.75	



HIGH INTENSITY RED LED BAR GRAPH

Dimensions:
Overall: 63mm across, 5mm high.
LEDs: 10 x 5mm x 1mm

Cat.No.	1-9	10+
Z10180	$2.95	$2.75



SPECTROL MULTIDIALS

MODEL 15-1-11

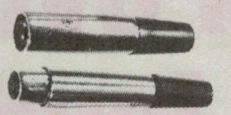
Number of turns: 10
Minor Scale Division: 1/500 turn
Shaft Bore: 6.35mm (¼")
Finish: Satin Chrome
Body Size: 25.4 x 44.45mm (1 x 1¾")
Depth: 25.4mm (1")
Weight: 45.4g (1.6oz.)
Cat.R14405 ..... **$45.95**
SPECIAL, $35.95

MODEL 16-1-11

Number of turns: 15
Minor Scale Division: 1/50 turn
Shaft Bore: 6.35mm (¼")
Finish: Clear Anodize
Body Size: 22.2mm diameter (.875")
Depth: 22.2mm (.875")
Weight: 19.8g (0.7oz.)
Cat.R14400 ..... **$26.95**
SPECIAL, $21.50

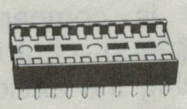
MODEL 21-1-11

Number of turns: 15
Minor Scale Division: 1/100 turn
Shaft Bore: 6.35mm (¼")
Finish: Satin Chrome
Body Size: 46.04mm diameter (1.812")
Depth: 25.4mm (1")
Weight: 85.0g (3oz.)
Cat.R14410 ..... **$46.95**
SPECIAL, $37.50



CANNON TYPE CONNECTORS

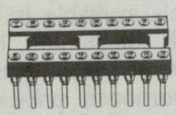
1-9	10+
P10960 3 PIN LINE MALE.	
$3.90	$3.50
P10962 3 PIN CHASIS MALE	
$3.00	$2.50
P10964 3 PIN LINE FEMALE	
$4.50	$3.90
P10966 3 PIN CHASIS FEMALE	
$4.95	$3.95



LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct Import" low profile IC sockets! PCB mounting solder tail. Dual wipe. All tin plated phosphor bronze or berryllium and dual wipe for reliability.

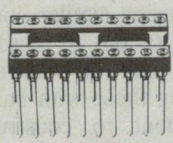
Cat.No.	Description	1-9	10+
P10550	8 pin	$0.20	$0.15
P10560	14 pin	$0.25	$0.20
P10565	16 pin	$0.35	$0.20
P10567	18 pin	$0.40	$0.30
P10568	20 pin	$0.40	$0.30
P10569	22 pin	$0.40	$0.30
P10570	24 pin	$0.40	$0.30
P10572	28 pin	$0.50	$0.40
P10575	40 pin	$0.50	$0.40



GOLD INSERT LOW PROFILE IC SOCKETS

- Gold machined pins
- Extremely high quality
- Anti-wicking.
- Ideal for professional use or where field service of components is required.

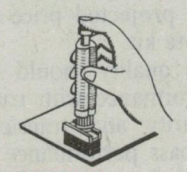
Cat.No.	Description	1-9	10+
P10620	8 pin	$1.20	$1.10
P10624	14 pin	$1.60	$1.50
P10626	16 pin	$1.90	$1.80
P10628	18 pin	$2.00	$1.80
P10630	20 pin	$2.20	$2.00
P10632	22 pin	$2.40	$2.20
P10634	24 pin	$2.60	$2.40
P10640	28 pin	$2.90	$2.60
P10644	40 pin	$3.00	$2.70



WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin-plated phosphor bronze.

Cat.No.	Description	1-9	10+
P10579	8 pin	$1.50	$1.40
P10580	14 pin	$1.85	$1.70
P10585	16 pin	$1.95	$1.80
P10587	18 pin	$1.95	$1.80
P10590	20 pin	$2.95	$2.70
P10592	22 pin	$2.95	$2.70
P10594	24 pin	$3.95	$3.50
P10596	28 pin	$3.95	$3.50
P10598	40 pin	$4.95	$4.50



IC INSERTERS

14-16 pin T12187	$8.95
18-20 pin T12189	$8.95
24-28 pin T12191	$9.95
36-40 pin T12193	$9.95

NEW TRANSISTORS

Rod Irving Electronics have two new transistors which will replace a multitude of common hard to get devices.

The PN100 is a NPN general purpose medium power amp and switch with continuous collector current up to 500mA.

The PN200 is a PNP general purpose amp at collector currents to 1 Amp.

Both are TO-82 plastic package

PN100 REPLACES:
PN2221, PN2222, PN2222A, PN3585, PN3568, PN3569, PN3643, PN5133, 2N2219A, 2N2222A, 2N3411, 2N3415, 2N3416, 2N3417, 2N3700, 2N3704, 2N3904, 2N4123, 2N4124, 2N4401, 2N5088, 2N5210.

PN200 REPLACES:
PN2907, PN2907A, PN3638, PN3638A, PN3640, PN3644, PN4121, PN4143, PN4248, PN4249, PN4250, PN4355, PN4916, PN4917, PN5910, 2N2905A, 2N3467, 2N3702, 2N3906, 2N4125, 2N4126, 2N4291, 2N4402, 2N4403, 2N5086, 2N5087, 2N5447.

PN100 Cat. T90001
PN200 Cat. T90002

1-9	10+	100+
$0.20	$0.18	$0.15

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Construction project:

Improved 72L 3-way hifi loudspeakers

Here are the details of a high quality 72 litre speaker system using the well-known Vifa driver units. The performance of the SA-130 system is comparable with commercial systems costing around $2500 – but it will cost you less than half this figure, even buying the enclosures in kit form. You can save even more by building these yourself.

by TOM MANNING Scan Audio, Melbourne

Loudspeaker construction in the home has never been so popular. Today, commercially available speakers proliferate, and whilst the quality of the many different models available is increasing due to tough competition, the rising labour costs involved in fully built speakers dictate proportionate price increments at the retail end of the production chain. This makes D-I-Y systems particualarly attractive, especially considering that the skills involved in construction speakers from proven designs are within the reach of most people with good practical abilities.

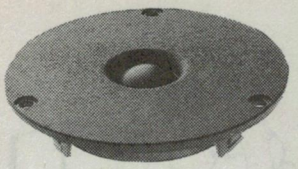
This article, describing a large speaker using the now well known Vifa drive units, is loosely based on an earlier and very popular system using similar components. The configuration is reasonably conventional, keeping the construction at a level enabling those with basic woodworking equipment to construct the cabinets from scratch.

To compliment the cheaper designs available in the Vifa kit range, an early design stipulation was that the SA-130 should compete sonically with imported speakers available for around $2500. To extract this maximum performance we began to look at various permutations available within our projected price of $1200 for the complete kit.

A speaker of this quality should be capable of bass performance with truly deep extension, clarity and transient ability. Since good bass performance is a function of size (and cost, usually!), this mandates the use of a relatively large woofer and enclosure. We narrowed down our choice to a few drivers capable of providing us with the desired performance. After considerable and deliberation, one unit stood out clearly: the Vifa P-25-Wo, a 250mm (10″) driver featuring a rigid alloy frame, large magnet and pole piece assembly and a thick magnesium enriched polypropylene cone. When loaded correctly, it promises ideal reproduction of the low registers, with transient ability and power handling to match.

Enclosing the woofer correctly is half the trick. Before making any decisions, we must consider a set of electrical and mechanical parameters which define our options by allowing us to predict, with

A pair of the new enclosures, one with front cloth fitted and the other "naked" to shows its drivers. Each enclosure measures 940 x 300 x 295mm.



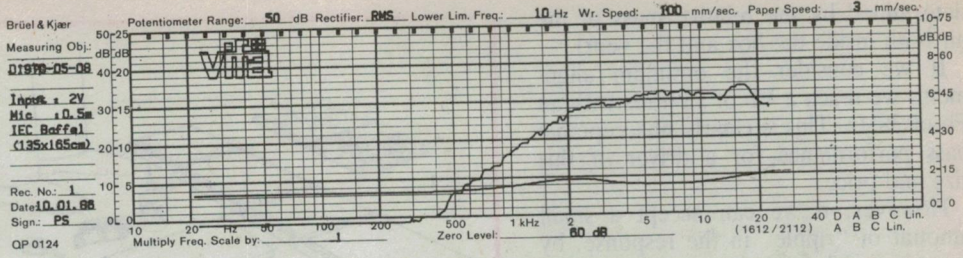
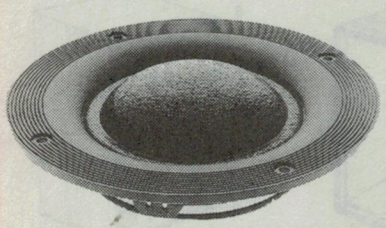


Fig.1: The tweeter used is the Vifa D19TD-05-08, a 19mm dome type with ferrofluid for cooling and damping.



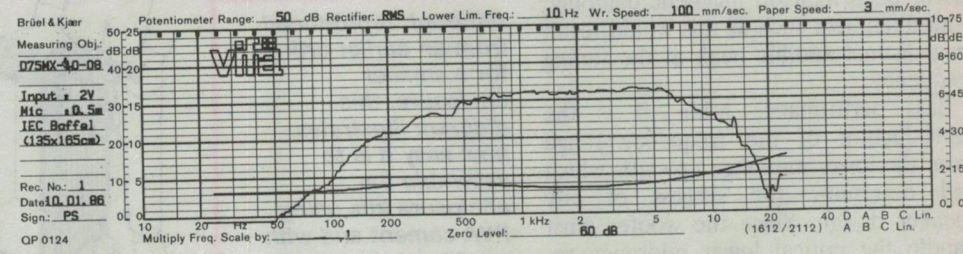
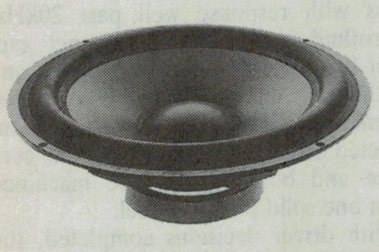


Fig.2: The mid-range driver is the Vifa D75MX-30-08, with a 75mm fabric dome and aluminium voice coil.



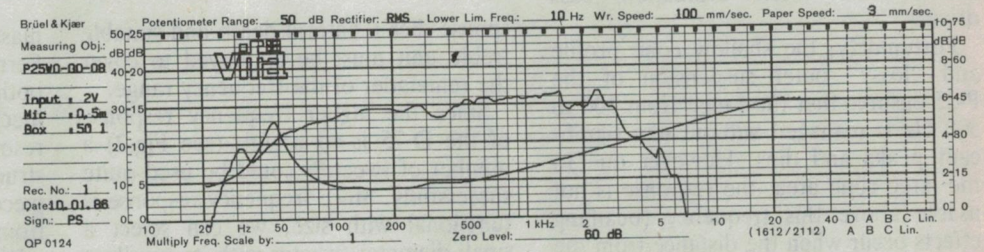


Fig.3: The woofer is Vifa's P25WO-00-08, a 245mm type with magnesium enriched polypropylene cone.

accuracy, the performance of the driver in several cabinet volumes with various bass reflex tuning ratios (alignments). The parameters in question are:

1. The free air resonance (Fo), which is the frequency at which the moving system of the driver exhibits the maximum output for the minimum electrical signal.

2. The total Q factor of the driver (Qt), which is the quality factor at resonance and which indicates the combined effects of the driver's electrical and mechanical damping of the moving system at its free air resonance.

3. The VAS, which is the volume of air in litres needed to provide the same restoring force to the cone as does the suspension. Expressed more generally, VAS gives an indication of the "springiness" of the suspension system.

Dictated largely by the Qt of the driver, usually just one option is available for the flattest frequency response. But thanks to the large magnet assembly providing high mechanical damping, and subsequent low Qt of the P-25, we are afforded some flexibility with our choices for Vb (cabinet volume) and Fb (frequency of maximum vent output,

SPECIFICATION	
MODEL:	VIFA SA-130
SYSTEM:	3-way bass reflex
WOOFER:	245mm (10″) VIFA P25WO-00-08
MIDRANGE:	75mm textile dome VIFA D75MX-30-08
TWEETER:	19mm dome ferrofluid VIFA D19TD-05-08
RATED POWER:	130 watt Peak
IEC POWER:	90 watt RMS
SENSITIVITY (1W/1m):	90dB
FREQUENCY RESPONSE:	28-20,000Hz
CROSS-OVER FREQ'CY:	800 & 3000Hz
TUNING FREQUENCY:	35Hz
IMPEDANCE:	8 ohms
INTERNAL VOLUME:	72 litres
DIMENSIONS (H x W x D):	94 x 30 x 29.5cm
WEIGHT:	24 kg

determined by the relative mass of the air both inside the box and the vent).

If we consider the optimum alignment, we reach a Vb of 53 litres with an Fb of 38Hz. This is clearly unacceptable bass performance for a driver of this size and price.

However, if we can accept a small amount of "ripple" in the response, by increasing Vb and lowering Fb somewhat we achieve a far more useful Fb of 29Hz with a Vb of 72 litres. Had the driver been light on magnetic damping, a misalignment such as this would result in a distinct audible peak at the tuning frequency.

Bass performance aside, it is the reproduction of the frequency range from the lower midrange upwards which will determine the success of any speaker design. Since the woofer must handle the critical lower midrange region, this must be an equally important consideration when evaluation bass drivers.

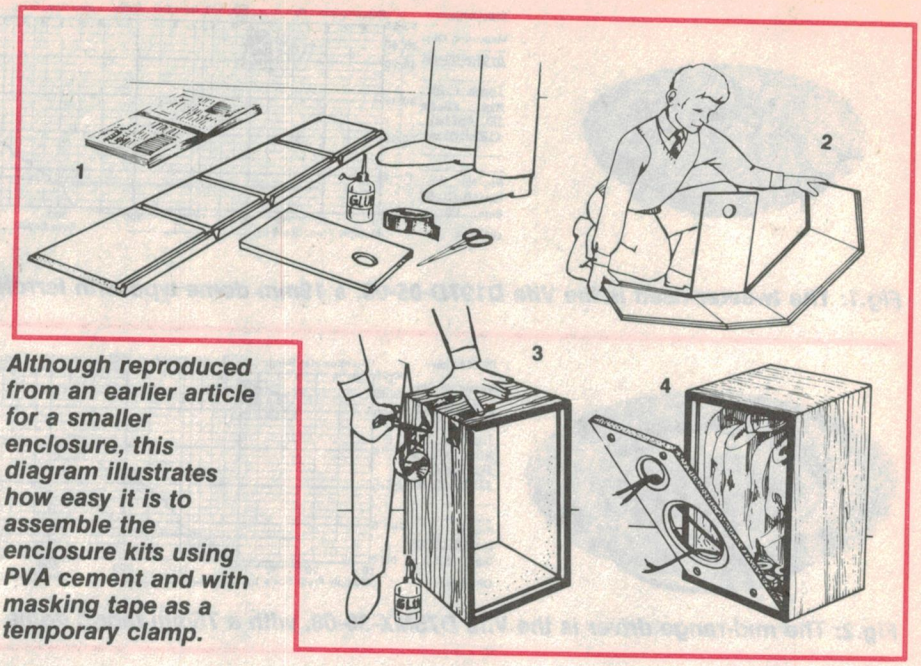
Fortunately, the shallow cone profile and "lossy" outer suspension of the P-25 ensures that the range from 100 to 500 Hz is managed without any significant peaks and dips. However due to the large cone area, the response is not usable above this frequency (beaming effects occur when the distance from the centre of the cone to the outside edge equals two wavelengths of the frequency being radiated) and here it becomes necessary to select a midrange unit capable of satisfying a new set of criteria.

The proposed midrange driver must be rugged, it must be compliant enough to handle the excursion necessary under high power at these frequencies, it must be small enough to respond well up into the kilhertz region, it must have clarity and good transient response.

Vifa manufactures several high quality midrange units. The most usable of these is a new 75mm (3″) unit, the D75MX-30-08. This circumferentially driven device uses soft fabric for the dome assembly, an aluminium voice coil former and a centrally enclosed magnetic assembly. The open back construction of the driver allows it to "breathe" most efficiently, providing a low free air resonance (Fo), of 250Hz.

With these qualities in its favour, it is ideally suited to cross over to the woofer at 500Hz. Furthermore, its low moving mass (3.7g) allows it to respond up to 6kHz where here it is only 3dB down.

But in life, death is unavoidable, and as the mass reactance of the dome becomes dominant with frequency, the response dies a natural death and suitable treble unit must be employed to cover the remainder of the frequency range.



Although reproduced from an earlier article for a smaller enclosure, this diagram illustrates how easy it is to assemble the enclosure kits using PVA cement and with masking tape as a temporary clamp.

Since the higher frequency response of the D-75 is so useful, (see Fig.2) a number of tweeters could be used quite successfully. Since frequency response is functional with size, we can select a small diameter tweeter with its excellent high frequency performance, without being concerned about potential reliability problems resulting from operating the unit at or near its natural resonance. (If this were allowed, the excessive excursion under high power will cause fairly prompt failure, ensured by the lack of flexible lead-in wires which are generally not fitted to tweeters of this size.)

The natural selection for the task is the Vifa D-19-TD – a 19mm dome unit of interesting construction. The dome is plastic-polyamide, providing very low mass with response well past 20kHz. Ferrofluid is used in the magnet gap, both for cooling under high power and mechancial damping of self-generated resonances. The voice coil is constructed from aluminium and the core piece and bottom plate are machined from one solid piece of steel.

With driver decisions completed, the crossover can now be tackled, the most challenging and important aspect of any proposed design. An examination of the circuit, (Fig.4) reveals that it's a mixture of roll off slopes – first, second and third order types being used.

This may seem at first to be an unwise choice, since it's usually desirable to apply symmetrical crossover functions throughout. But loudspeaker drivers are imperfect devices, and before considering any electrical functions, it's necessary to examine the acoustical behaviour of the drivers in question.

Starting with the woofer, L1 and C1 form a second order electrical filter at 500Hz. This, coupled with the driver's natural acoustical roll off provides an overall acoustical attenuation of around 20dB per octave. C2 and R1 are used for impedance compensation, C2 exhibiting a reducing impedance characteristic with rising frequency.

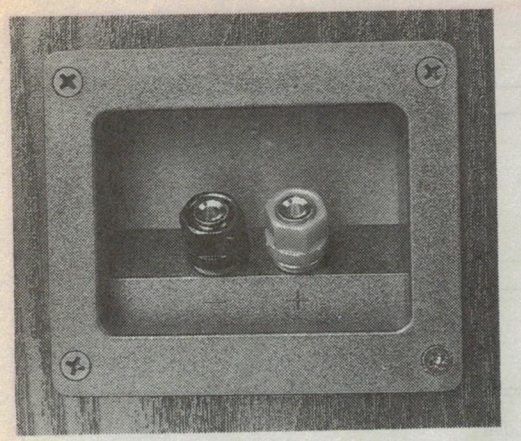
Moving on to the midrange section we must now implement a band pass filter to ensure that the driver copes adequately with its assigned frequency range. C3 forms the high pass section, providing 6dB of electrical attenuation. Together with the natural droop in driver response below 500Hz, the resultant acoustical behaviour is in the region of 24dB per octave.

KIT PRICE & AVAILABILITY

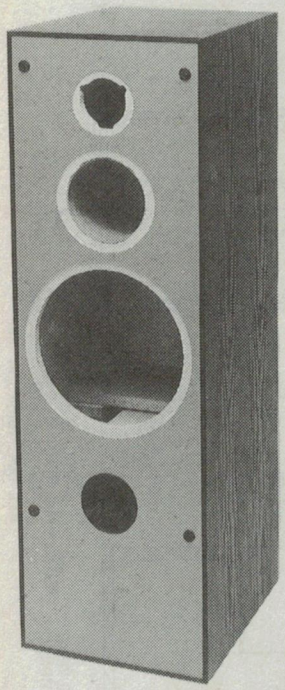
Kits for the Vifa SA-130 speaker system are available from the Australian importer for Vifa, Scan Audio Pty Ltd of 52, Crown Street, Richmond Victoria 3121.

Complete kits including cabinets (in flat-pack form) are priced at $1199.00 per pair, while kits complete except for the cabinets are $929.00 per pair.

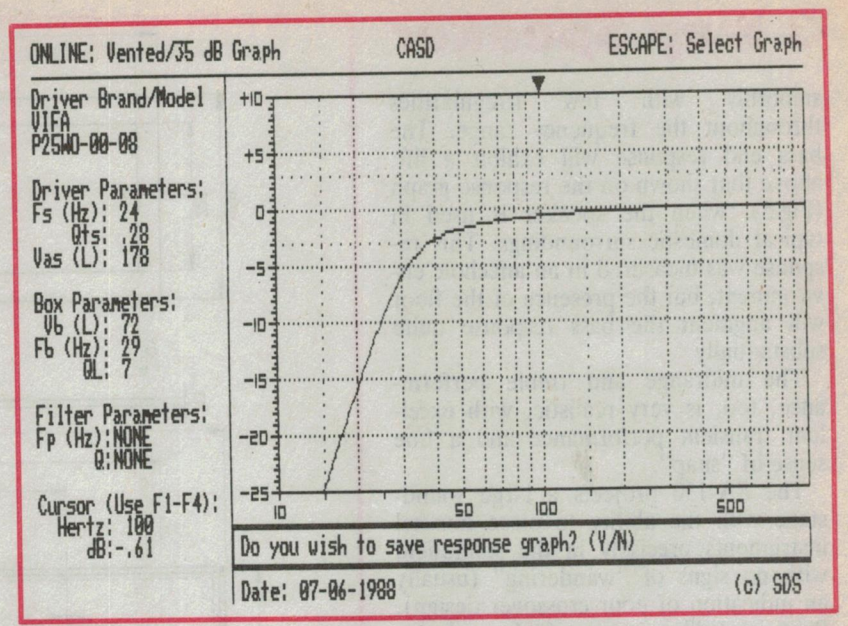
Scan Audio can also supply the various drivers units separately, if required.



Above: a close-up of the terminal block, fitted to the case rear with screws and sealant.



Above: How the assembled enclosures should look before the drivers are fitted.



Above: Response of the P25WO woofer in a 72L volume, as plotted.

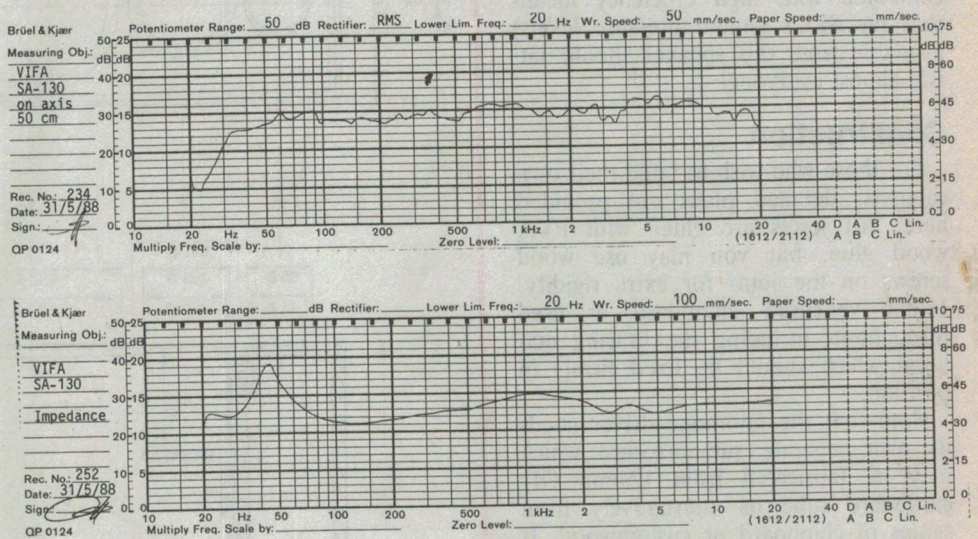


Fig.5: The measured frequency response of the final enclosure (upper curve), and its impedance curve – both measured between 20Hz and 20kHz.

The low pass section, however, uses a third order filter, comprised of L3, C4 and L4, chosen to avoid operating the driver in the region of 6kHz where its response becomes quite erratic due to break-up modes in the dome assembly. L2 and R3 serve as a step filter, defeating a small rise at 4kHz in the driver's on-axis response. Coupled with R2, the overall sensitivity of the driver is reduced about 2dB to match its output to that of the woofer's.

Lastly, the treble section. Here C5, L5 and C6 are the reactive components, forming a third order filter which provides high power handling by reducing the dome excursion substantially compared with less steep slopes. R4 (3.3 ohms) is used to provide about 3dB of attenuation thoughout its operating band.

As a system, the response extends

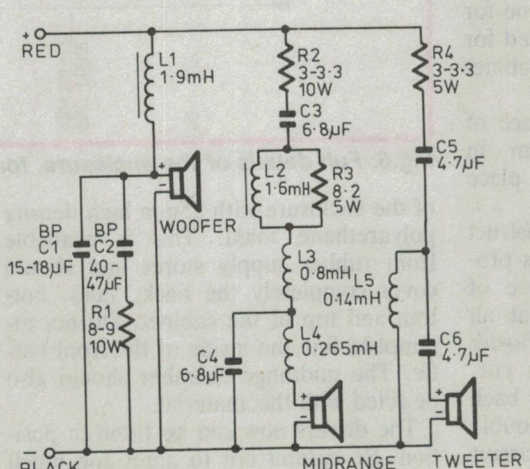


Fig.4: The circuit for the crossover network, together with the parts used.

CROSSOVER PARTS LIST

1	1.9mH ferrite max. 0.45 ohms
2	1.6mH air or ferr. max. 1 ohm
3	0.8mH air max. 0.4 ohm
4	0.265mH air max. 0.3 ohm
5	0.14mH air max. 0.5 ohm
1	15-18uF bipolar 50 Volt
2	40-47uF bipolar 50 Volt
3	6.8uF film polyester
4	6.8uF bipolar 0 Volt
5	4.7uF film polyester
6	4.7uF film polyester
1	8-9 ohms 10 watt
2	3-3.3 ohms 10 watt
3	8.2 ohms 5 watt
4	3.3 ohms 5 watt

smoothly with few irregularities throughout the frequency range. The bass end response will exhibit a lift, above that shown on the response graph (Fig.5), when the speaker is used in typical domestic surroundings. This response was measured in an anechoic environment, but the presence of the floor will augment the bass response quite substantially.

The midrange and treble performance, too, is very realistic, with excellent transient performance and a fine sense of "snap".

The SA-130 projects a large soundstage with the ability to place musical instruments precisely in the soundfield with no signs of "wandering" (usually an indication of poor crossover design). Power handling is very high, and this combined with high efficiency means that the SPL's (sound pressure levels) available from this speaker should satisfy almost everyone!

Construction

For those who wish to build their own cabinets, detailed plans are provided here. All joints are glued with PVA wood glue, but you may use wood screws on the joins for extra rigidity. 18mm veneered chipboard is used throughout, including the bracing material which should be fixed firmly in position.

Note that the midrange driver needs its own separate sub-enclosure which may be fabricated from 124mm OD cardboard tube or alternatively from scraps of chipboard or customwood. It is absolutely essential that this chamber be completely sealed, to avoid back pressure from the woofer from modulating the midrange dome. Use silicone for this purpose, which can also be used for sealing all inside joints of the cabinet once it's completed.

The bass port is cut from a piece of 90mm PVC sewer pipe, 16mm in length. This should be glued in place with epoxy resin or PVA glue.

For those who intend to construct your own crossovers, a parts list is provided. Hardwire these on a piece of scrap chipboard, making sure that all components are glued securely. Bostik hot melt glue is excellent for this purpose. Secure the crossover to the back of the cabinet, once you have double checked your wiring against the circuit diagram. Pay particular attention to driver phasing.

This done, you should line the inside of the enclosure with 25mm high density polyurethane foam. This is available from rubber supply stores and should cover completely the back, sides, bottom and top of the cabinet. Do not attempt to line the inside of the front baffle. The midrange chamber should also be filled with this material.

The drivers now can be fitted in position. Be careful not to apply too much heat when soldering to the terminals of the tweeter and midrange. (Before mounting the midrange driver, make sure that the lead in wire to the small chamber is sealed off with silicone or similar sealant).

Now that the system is completed, you should check the bass drivers for phase. Take a 1.5 volt battery, connect positive to positive on the rear terminal and the woofer cone should move out. If it moves in, you have made a wiring error and should re-check all connections. If everything is okay, select a favourite record and settle back to enjoy the sound!

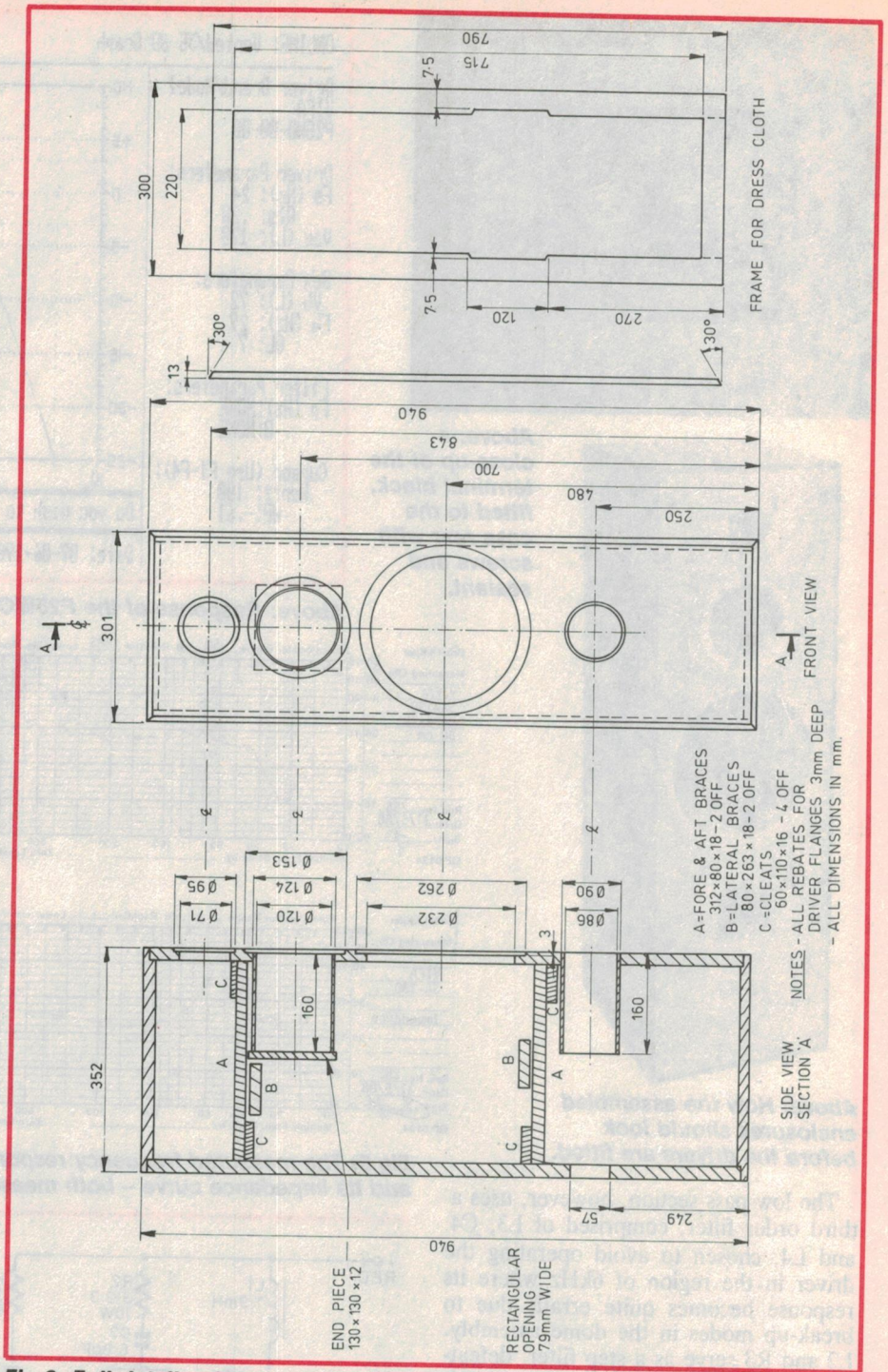


Fig.6: Full details of the enclosure, for "rolling your own".

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For full specifications and descriptions check our 1988 catalogue. Be quick, stock is limited and won't last.

Cat	Description	Normal price	Sale price
AA-0380	Jaybrik 50W amp module	99.00	69.00
AA-0382	Jaybrik 100W amp module	125.00	95.00
AC-1600	Head demagnetiser 240V	14.95	8.95
AC-1678	Speaker switch - 5 pairs	63.95	45.00
AC-1958	Mono/stereo erase head	7.95	4.95
AA-2019	Headphone - light high quality	24.95	13.95
AA-2024	Professional style headphone	22.95	12.95
AA-2025	Headphone AM/FM radio	39.95	19.95
AA-2026	Headphone - fold up type	9.95	4.95
AA-2060	Speaker mounting brkts - pair	79.00	49.00
AA-2091	Car radio ant - spring base	12.95	6.95
AS-3017	7 x 5 15 ohm car radio spkr	12.50	6.00
AS-3050	Pillow speaker	12.95	7.95
AS-3182	5 x 8 PA w'proof speaker	42.95	27.95
AS-3303	Hi quality earphone for TV's	6.99	3.99
AM-4103	Mic screw adap 1/4"-3/8" male	1.95	0.85
AM-4110	Two microphone attachment	9.95	2.95
AM-4180	PA Megaphone - professional	135.00	89.00
AM-4210	30 watt PA amp	229.00	150.00
AM-4212	100 watt PA amp	469.00	340.00
AV-6505	Video switching box	39.95	19.95
AV-6532	Lead 5 PIN - 5 DIN reverse	7.95	3.50
BS-0404	Book - intro Auto solid state	19.95	9.95
BS-0406	Bk - Soul of CPM	39.95	19.95
BS-0412	Bk - Printer connections bible	29.95	16.95
BS-0416	Bk - Macintosh program tech	44.50	22.00
BS-0420	Bk - C prog tech for MAC	37.95	17.95
BS-0422	Bk - Computer conn solved	37.95	17.95
BS-0450	Bk - Basic elect technology	39.95	18.95
BS-0452	Bk - Basic elect and DC circ	39.95	18.95
BS-0453	Cassettes to use with BS0452	26.50	13.50
BS-0456	Bk - Understanding microproc	27.95	14.95
BS-0458	Bk - Underst Digital electronics	27.95	14.95
BS-0550	Bk - H'book elect tables & form	34.95	17.95
BS-0560	Bk - Cable TV	21.00	10.00
BS-0590	Bk - 8080/8085 s/ware design	24.95	10.00
BS-0602	Bk - Microcomp for bus'n app	15.95	7.95
BS-0703	Bk - Crash course - digital tech	34.95	18.95
BS-0714	Bk - Intro Apple MAC	21.95	11.95
BS-0720	Bk - Fibre optics exp & proj	26.95	13.95
BS-0725	Bk - Semi gen purp replace	34.95	19.95
BS-0730	Bk - How to read schematics	27.50	12.95
BS-0732	Bk - Comp car audio	19.95	9.95
BS-0733	Bk - Data Comm, Netw & sys	75.00	35.00
BS-0737	Bk - Advanced Unix prog guide	42.00	21.00
BN-4040	Bk - National Hybrid products	17.95	10.00
BN-4045	Mos memory - National	17.95	10.00
CR-2180	10" passive radiator	36.50	16.50
CR-2190	12" passive radiator	47.50	20.00
CE-2324	8" 20W 4 ohm laser twin/c spkr	19.95	12.95
CB-2360	PA box to suit 8" spkr	26.50	16.50
CX-2618	X'over - 3 way 400Hz/4.5kHz	8.95	4.95
HP-1225	Spkr Mnt lugs pk 6	0.49	0.20
HK-3110	Perspex sheet 150 x 100mm	2.95	1.75
HM-3182	12 way PCB mnt screw term	4.25	2.00
HM-3822	Metal croners for spkr boxes	2.50	1.40
HB-5480	Instru case 90x125x190	25.95	14.50
HB-5481	Instru case 140x175x220	31.95	17.00
HB-5482	Instru case 145x115x210	31.95	17.00
HB-5483	Instru case 200x90x220	31.95	18.00
HB-6060	Weatherproof outdoor case	29.95	16.50
HB-6300	Plastic drawer - single	5.50	2.85
HB-6301	Plastic drawer - double	5.50	2.85
HH-8500	H'sink brkt 4 x TO3	2.50	1.00
HP-9524	PCB 300x300mm d/side thin	9.95	5.00
KA-1010	Musicolor 4 kit	125.00	85.00
KA-1225	Trans & FET tester kit	26.50	15.50
KA-1452	Subwoofer mosfet amp kit	125.00	95.00
KA-1555	CQAM stereo decoder kit	26.50	13.50
KA-1559	Railmaster walkaround kit	13.95	6.50
KA-1560	Railmaster controller kit	109.95	79.00
KA-1561	Railmaster diesel sound kit	22.50	9.50
KA-1562	Railmaster steam sound kit	22.50	9.50
KA-1563	Lighting control railmaster kit	21.95	11.95
KA-1622	225W/4 ohm mosfet amp mod	99.50	55.00
KA-1624	CD attenuator kit	9.95	5.00
KA-1626	Video fader kit	24.95	12.95
KA-1636	AM/FM tuner remote cont kit	99.50	69.50
KA-1645	CD adaptor kit	18.00	9.95
KA-1674	Photo timer - digital kit	89.95	55.00
KA-1679	Turbo timer kit	29.95	19.95
KA-1680	Audio oscillator low dist kit	139.00	85.00
KA-1684	8 chan I/R transmit kit	45.00	22.50
KA-1685	IR receiver (std) kit	127.95	75.00
KA-1686	IR receiver (add on) kit	55.00	25.00
KM-3010	60W mosfet amp kit	59.50	29.50
KM-3012	120W mosfet amp kit	79.50	45.00
KM-3016	RTTY encoder kit	32.50	19.50
KM-3048	Car alarm current drop kit	49.50	32.50
KM-3054	Audio clipping ind kit	14.50	10.00
KM-3058	64 Pkt radio kit	59.95	42.50
KM-3060	Bal line driver kit	99.50	50.00
KM-3062	RS-true-232 interface kit	24.95	12.50
KM-3063	Uo satellite decoder kit	55.00	29.50

Cat	Description	Normal price	Sale price
KM-3066	VHF rec for weather set kit	99.00	59.00
KE-4000	Buzz board kit	5.50	3.00
KE-4002	Electronic siren kit	5.90	4.00
KE-4012	12V flasher kit	9.95	4.50
KE-4013	Microwave oven det kit	17.95	9.95
KE-4202	ETI5000 preamp kit	399.00	300.00
KE-4204	ETI5000 graphic eq kit	219.00	159.00
KE-4678	ETI340 car alarm kit	79.50	45.00
KE-4708	DI box kit	42.50	26.50
KE-4720	Digital sampler kit	119.00	75.00
KE-4726	Telephone screamer kit	29.95	17.50
KE-4731	Telephone intercom kit	59.95	37.50
KE-4732	Baby minder kit	34.95	20.00
KC-5011	Off hook indicator kit	12.95	6.50
KC-5014	Subcarrier adaptor kit	22.95	11.50
KC-5018	50W amp module kit	32.95	18.95
KC-5020	Door minder kit	37.50	19.95
KC-5022	Dual track p/supply kit	99.95	67.50
KC-5024	Modem end-file-ind kit	9.95	5.50
KC-5025	Line grabber - telephone kit	19.95	12.95
KJ-6692	Solar power 150 in 1 exp	39.95	25.00
KJ-6694	Electronics 60 in 1 exp	32.50	16.00
KJ-6695	Electronics 120 in 1 exp	42.50	26.50
KS-8103	Transistor tester kit	15.50	8.50
KS-8107	Electronic dice kit	10.95	6.00
KS-8108	Power supply 1.5/12V kit	13.95	5.95
KS-8126	NiCad batt charger kit	17.95	8.50
KS-8127	Siren Kit	8.95	3.95
KS-8129	Simple Timer kit	11.95	5.95
LF-1200	RF choke atten 10-100MHz	1.00	0.50
LF-1300	Whistle filter - Jabel	23.95	12.00
LT-3015	FM band rejection filter	7.95	3.50
LT-3063	Telescopic radio antenna	8.95	5.00
LT-3064	Telescopic radio antenna	9.95	5.00
LT-3120	Caravan UHF,VHF,FM amp	99.00	49.00
LT-3150	TV ant Ghostbuster UHF,VHF	109.50	69.50
LT-3166	VHF metro ant TV	39.95	25.00
LT-3170	Gutter grip TV ant	32.50	22.50
LT-3190	Sportsman TV ant ch 4&5	59.95	29.95
LM-3845	Video modulator LVM2A34	12.95	5.95
LA-5010	Mini burglar alarm	29.50	9.95
LA-5062	Alarm emergency P/button	3.85	1.00
LA-5064	Glass break detector	5.95	2.95
LA-5073	Roller shutter contact	37.50	19.95
LA-5270	4" 12V alarm bell	14.95	9.50
MM-1800	Telecom power transformer	30.00	15.00
MT-3800	T/phone line T/F experimental	2.00	0.50
MS-4005	IEC mains filter 8 amp	29.95	15.00
PS-0125	3.5mm line skt, red, mono	0.65	0.20
PS-0196	6.5mm line skt, stereo, metal	2.25	1.00
PP-0684	BNC line female crimp	2.20	1.00
PS-0866	37D right angle socket	11.95	5.00
PS-0903	50 way Centronics type skt	5.00	2.00
PP-0992	IDC he 16 way rt angle econ	3.50	2.00
PP-0994	IDC he 34 way rt angle econ	5.50	3.00
PP-0996	IDC he 50 way rt angle econ	7.95	5.00
PM-2700	3 pin line plug & skt	1.50	0.75
PA-3512	Adaptor mic conn/RCA skt	1.95	0.50
PA-3516	Adaptor mic conn/6.5mm skt	1.95	0.50
PA-3658	Adaptor 5 pin DIN - reverse	7.95	2.50
PA-3670	Adaptor DC 2.1 skt/1.3 plg	2.20	1.20
PA-3672	Adaptor DC 2.5 skt/1.3 plg	2.20	1.20
PI-6510	8 pin w/w IC skt	1.00	0.30
PI-6513	18 pin w/w/ IC skt	2.50	1.00
PI-6515	22 pin w/w IC skt	2.50	0.50
PI-6519	24 pin w/w IC skt gold	4.95	1.50
PH-9234	216 batt PC mount holder	3.75	2.00
QM-3510	Magnifier round, econ	14.95	7.00
QM-3512	Magnifier bifocal/light	27.95	15.00
QM-3520	Microscope 30X light	24.95	12.00
QP-6105	Blood pressure monitor	129.50	85.00
QC-7160	Little Professor - Texas	29.95	20.00
QC-7114	Calculator - computer style	15.99	9.00
QC-7125	Solar calculator desk/pocket	17.95	11.00
RP-3806	1K log switch pot	2.95	0.50
RP-3814	50K log switch - pot	2.95	0.50
RP-3831	5K radio on/off vol switch	2.25	0.75
RG-5179	3.3uF 63V greencap	2.25	0.75
RG-5183	4.7uF 250V polycarbonate	5.50	2.00
RG-5185	5.6uF 100V polycarbonate	5.50	2.00
RG-5195	0.1uF 400V PME polyester	0.85	0.10
RG-5198	Precision 1&2% cap pack	12.50	5.00
RC-5400	CSA5 300K resonator	3.95	1.50
RC-5450	Decooling cap 0.02uF 14 pin	1.50	0.20
RE-6241	2200uF 35V RB electro	2.50	1.00
RZ-6625	0.33R 35V RT tant mil spec	0.50	0.05
RZ-6627	0.68R 35V RT tant mil spec	0.50	0.05
RZ-6646	6.8uF 35V RT tant mil spec	0.65	0.10
RZ-6680	150uF 20V mil spec tant RT	0.75	0.10
RZ-6681	22uF 35V mil spec tant RT	0.85	0.10
RZ-6682	47uF 20V mil spec tant RT	0.95	0.15
ST-0569	Swi mini SPDT c/off spring	5.50	2.00
SP-0702	P/button sw 10A p/on or p/off	3.95	1.25
SP-0800	Paddle switch SPDT grey	2.95	1.00

Cat	Description	Normal price	Sale price
SZ-2040	Fuse puller	3.95	1.75
SC-2282	Circuit break DP with switch	5.95	2.50
SL-2571	6V large green bezel	1.20	0.20
SL-2625	12V orange bezel	1.95	0.40
SL-2626	12V green bezel	1.95	0.40
SL-2760	Fluro lamp/torch 3 x C cell	19.95	12.00
SY-4067	24V PCB relay SPDT 3A	1.95	0.40
TS-1390	Weller tip CT5 BB8 2.4mm	4.95	0.50
TS-1391	Weller tip CT5 CC8 3.2mm	4.95	0.50
TS-1392	Weller tip CT5 DD8 5mm	4.95	0.50
TS-1393	Weller tip CT5 EE8 6.4mm	4.95	0.50
TS-1476	Adcola desolder pen for EO24	79.95	55.00
TH-1768	Nibbling tool - Kingcraft	19.95	12.50
TH-1795	Cable tie gun	14.50	7.50
TH-1835	National inspection light	23.95	13.95
TH-1842	Pearl catch	6.50	3.50
TH-1844	Tapered reamer 5-20mm	15.95	9.95
TH-1950	Art knife with 25 blades	9.95	5.50
TH-1952	Utility knife - small	2.99	1.75
TH-1954	Utility knife - medium - saw	14.95	7.95
TH-1955	Touch knife - pocket type	1.99	1.20
WM-4518	24 way rainbow cable - metre	4.95	2.50
WS-5510	Heatshrink tube pack - asst	3.50	2.00
WS-5512	Heatshrink tube 3.5mm 2 mt	3.50	1.20
WS-5514	Heatshrink tube 5mm 2 mt	3.95	1.30
WS-5516	Heatshrink tube 7mm 2 mt	3.50	1.30
WS-5518	Heatshrink tube 10mm 2 mt	3.50	1.40
WS-5520	Heatshrink tube 12mm 2 mt	3.50	1.70
XC-0110	Pendulum driver	14.95	4.95
XC-0122	Melody module 12 songs	14.95	5.95
XC-0130	Twinkle little star module	3.95	1.50
XW-0250	Quartz clock/compass	5.95	2.95
XW-0390	Digi alarm clock with temp	27.95	14.95
XW-0392	Temperature alarm clock travel	29.95	18.95
XW-0395	Car digital LED alarm clock	24.50	10.00
XM-0600	Brake lamp flasher	12.95	6.95
XR-1030	Elami junior robot	99.00	69.00
XV-2210	Teledek 2000 Viatel unit	129.00	79.00
XM-4500	Green screen 12" monitor	229.50	139.50
XS-4840	Multicom 2 software	149.50	79.50
XC-5016	I/O plus 2 card PC/XT	139.00	79.00
XC-5020	Multi I/O board PC/XT	199.00	109.00
XC-5050	150W power supply PC/XT	159.00	100.00
XS-7000	Centronics printer switch	99.00	65.00
YT-6540	Std block for phones	34.95	22.50
YT-7070	Porsche 928 telephone	49.95	29.95
ZD-1931	PC817 1 x optocoupler 4 pin	1.20	0.40
ZD-1932	PC837 3 x optocoupler 12 pin	2.00	0.50
ZD-1980	LED/CDS cell opto isolator	3.00	0.50
ZT-2245	MJ3000 TO3 darl 60V	10.00	2.00
ZL-3170	UAA170 LED driver	4.20	1.00
ZL-3370	LM370 IC	1.00	0.20
ZC-4032	4032 Triple serial adder	3.50	1.50
ZC-4034	4034 8 stg tri-st uni busrg	2.95	1.00
ZC-4035	4035 4 bit shift register	1.50	0.50
ZC-4500	4500 indust cont unit	7.95	4.00
ZC-4517	4517 dual 64 bit stat shftre	5.50	1.50
ZC-4557	4557 1-64bt var-ing shftre	8.50	3.75
ZC-4580	4580 4 x 4 multiport regstr	10.50	4.50
ZC-4581	4581 4 bit alu	4.50	2.00
ZS-5810	7410 triple input NAND gate	0.25	0.05
ZS-5853	7453 exp 4 wide 2 I/P an/or	1.20	0.40
ZZ-8072	CDP1822	11.50	2.00

SEE JAYCAR'S ADS IN THIS MAGAZINE FOR STORE ADDRESSES & PHONE No's.

TURN YOUR SURPLUS STOCK INTO CASH!!

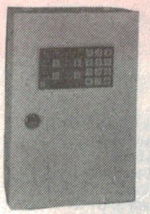
Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.

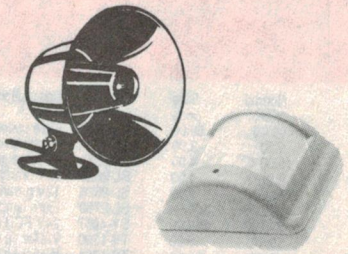
CALL GARY JOHNSTON OR BRUCE ROUTLEY TODAY ON (02) 747 2022

JAYCAR'S SENSATIONAL

ALARM EQUIPMENT 10% OFF

- Panels
- PIR's
- Keypads
- Stickers
- Sirens





TV ANTENNAS & ACCESSORIES

10% OFF

- Antennas
- Amplifiers
- Wall sockets
- Splitters
- Baluns

ILLUMINATED ROCKER SWITCH

- Great for amps • SPDT, 8A, 240V
- Illuminated actuator • As used in P/master 60/60 • Size 21 x 15mm
- Panel cutout 13 x 19.5mm

Cat. SK-0965
Original price $7.50 ea
SPECIAL PRICE $3.95

BARGAIN PRICE FOR SEPT

$1.95 each

25% OFF CROSSOVERS

Take 25% off all the following crossovers.

Cat	X'over	Freq
CX-2611	2 way	2kHz
CX-2612	2 way	3.5kHz
CX-2614	2 way	3.5kHz
CX-2615	3 way	800, 5kHz
CX-2616	3 way	800, 5kHz
CX-2621	3 way	800, 3.5kHz
CX-2619	3 way	600, 3.5kHz

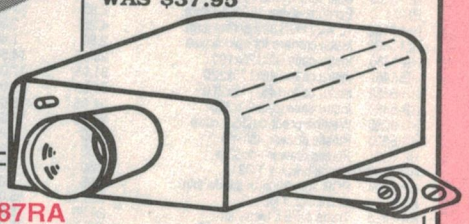
Power	Normal	Sale (ea)
65W rms	18.95	14.21
50W rms	13.95	10.46
40W rms	9.95	7.46
40W rms	15.50	11.62
65W rms	28.95	21.71
200W rms	69.50	52.12
80W rms	32.95	24.71

DUMMY CAMERA BARGAIN - 25% OFF

We all know that shoplifting and vanalism cost a small fortune very year. It has been demonstrated that television surveillance cameras in the right environment can discourage this activity.
This is where you come in.
We have made a great purchase of realistic-looking Dummy TV Cameras.
They are Australian made, are supplied with adjustable swivel mounting bracket, fixing screws, flashing LED circuit board and 2 flashing LEDs. Also supplied is the 2 x D cell nylon battery holder to power the flasher circuit. A fake cable wallplate is also supplied as well as a very conspicuous 210(W) x 160(H) self adhesive sign which says "THESE PREMISES ARE PROTECTED BY TIME-LAPSE ANTI-THEFT CAMERAS" The text of the sign is in orange-red fluorescent ink against a black background.
BUT HURRY! We have around 300 only.

Cat. LC-5310

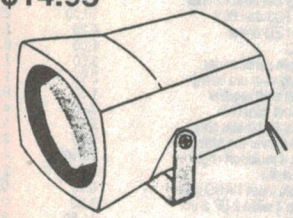
1 - 4 pcs	$37.46
WAS $49.95	
5 - 9 pcs	$32.21
WAS $42.95	
10 - 19 pcs	$29.96
WAS $39.95	
20+ pcs	$28.46 ea
WAS $37.95	



TWEETY PIE

This incredible little piezo screamer measures 87(L) x 38(H)mm emits a 116dB wail. It's deafening! As used in the screamer car alarm kit.
Cat. LA-5255

NORMALLY $17.95
SAVE $3 ONLY
$14.95



8" TWIN CONE SPEAKER BARGAINS

4 ohm 10 watt 8"
Cat. CE-2322
NORMALLY $8.95
SALE $5.95
SAVE $3

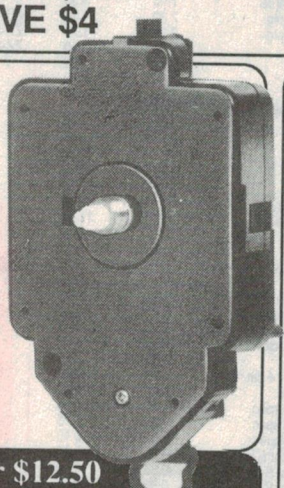
8 ohm 10 watt 8"
Cat. CE-2325
NORMALLY $13.95
SALE $9.95
SAVE $4

CLOCK MOVEMENT WITH BUILT-IN PENDULUM DRIVER

This module measures 87mm long x 55 wide x 35mm deep and uses 1 x AA battery. Clock movement is supplied with 3 sets of hands, and pendulum is a suspended arm within the module which swings back and forth. A suitable pendulum can be attached to the bottom of the arm.
Fit your own custom clock face.
Great for novel applications.
Cat. XC-0103

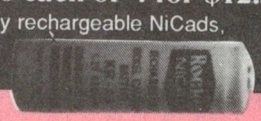
DIRT CHEAP!!

WAS $22.95
NOW $16.95
SAVE $6.00



AA NiCads $3.50 each or 4 for $12.50

Don't waste money. Buy rechargeable NiCads, 450mA. Quality brand.

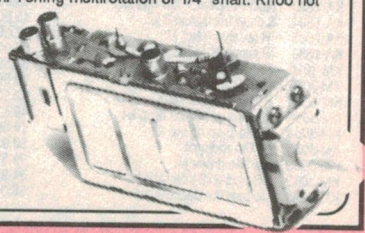


UHF TV TUNER
Sanyo Model T1087RA

Yet another fabulous scoop purchase.
A compact high quality tuner that operates from 526-814MHz (corresponding to channels 28 thru 63). This tuner is designed for Australian standard reception (AS1053 1973), and is offered at a very low price.
You can grab one now for the silly price of $29.95! This price includes circuit diagrams and connection drawing. You can have a photocopy of the complete manual for $4 but a lot of the info is in Japanese!
This is a very cheap way to convert a VHF only TV to UHF! (Some skill may be required).
Specs:
Power +12V DC nominal @ 14mA. Case neg. Bandwidth 526-814MHz (28-63 ch). AFT +6.5V. Dimensions 150 x 65 x 28mm. Tuning multirotation of 1/4" shaft. Knob not supplied.

Cat. DM-1000

NORMALLY $29.95
NOW $14.95
SAVE $15.00



SEPTEMBER SALE

SAVE 30% ON BUG BOXES

Bug boxes are a range of plastic antistatic enclosures basically for IC's. The system is completely modular. You can purchase a single tray or establish a full blown storage and retrieval system from the modules. Refer to our 1988 catalogue for full details.

BUG BOX

A flat tray with clear locking lid. Will hold 60 x 8 pin or 30 x 14, 16, 18 or 20 pin IC's. Slides into cage described below.

NORMALLY $5.95 NOW $4.15

Cat. HB-6350

LSI BUG BOX

Same as Bug Box, but with larger compartments.

NORMALLY $7.95 NOW $5.55

Cat. HB-6358

BUG CASE

Moulded cabinet, will accept up to 6 bug boxes.

NORMALLY $9.95 NOW $6.95

Cat. HB-6366

BUG CAGE COVER

A clear acrylic door which clips on bug cage and holds boxes in.

NORMALLY $6.95 NOW $4.85

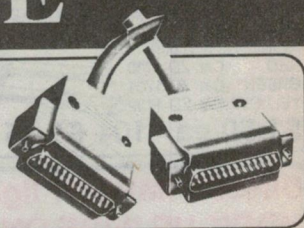
Cat. HB-6370

LSI BUG BOX

Computer Leads

Lower Everyday Prices

DIRT CHEAP!!



	WAS	NOW	Cat. No
• 25D plug - Centronics lead	28.95	18.95	PL-0854
• 25D plug - 25D skt lead	32.95	19.95	PL-0855
• 25D plug - 25D plug lead	30.95	19.95	PL-0856

PUSHBUTTON SWITCH

Quality Japanese made DPDT push on/push off switch rated at 125V 3 amp. Complete with black round knob. These are commonly used as on/off power switches for mains products, and normally cost about $4 - $5.
Jaycar has a quantity available for only $1.95.
Cat. SP-0730

$1.95 ea
10+ $1.75 ea

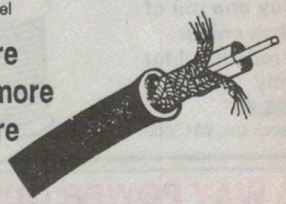
Knobs available separately:
Cat. HK-7791 **50¢ ea**

75 OHM AIR SPACED COAX

FOR THE PRICE OF ECONOMY COAX

Yes, for a short time only, you can purchase HIGH QUALITY air spaced 75 ohm coax for the same price as our economy 75 ohm cable.
Normally its $1.20 per metre, but you can buy it for only 80¢ per metre.
Or, if you buy 50 metres or more, it's only 60¢ metre.
That's half price!
Cat. WB-2006

80¢ metre
50m or more
60¢ metre



0.001uF 2KV CERAMIC

High voltage capacitor bargain.
Normally about $1.50 each

5 for $2.50

Cat. RC-5378

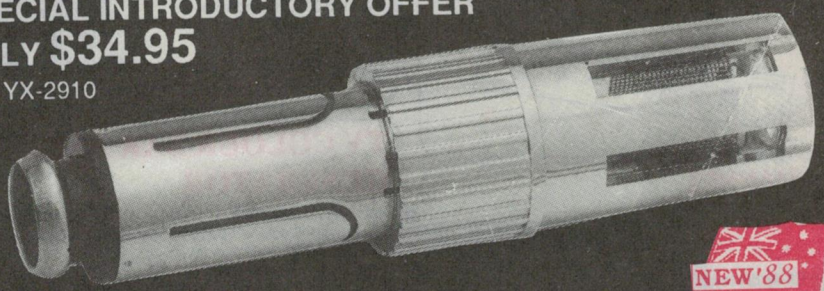
CAR NEGATIVE ION GENERATOR

Now you can have all the benefits of your home ioniser in your car.
This great new Jaycar direct import is durable, stylish and compact, measuring only 110mm in total length. It simply plugs directly into the cigarette lighter socket in your car. It can generate large amounts of negative ions for purifying air, and some ozone for eliminating odour.
Jaycar's direct importing cuts out the middle man and saves you money.

SPECIAL INTRODUCTORY OFFER

ONLY $34.95

Cat. YX-2910



NEW'88

TRIGGER SWITCH BARGAIN

$2.00 Cat. SP-0760

This is a DPST 240V 1.5A switch mechanism that is actuated by a 'trigger' similar to the trigger in a modern electric drill.
We haven't a clue what you could use them for - you work that out!
But this component working-for-an-pllication is cheap at least. Made in the UK quality. Worth over $10 but this month only $2.00!

BNC MALE TO 'N' MALE ADAPTOR

High quality UK made 'Greenpar' brand. Converts BNC male to the type 'N' fitting used in satellite receivers and other microwave gear. 'N' connector has male centre pin. The outer connector is a male threaded fitting. (Not constant impedance).
A rare component and worth collecting at this price.
Cat. PA-3685

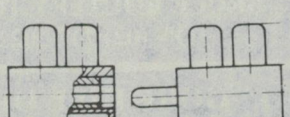
ONLY $3.00

DIRT CHEAP!!

PLUG & SOCKET TERMINAL STRIP

Brand new product. It's like a standard type 12 way barrier strip or terminal strip but its 2 strips of 12 which can be unplugged from each other. So if you have any number of semi permanent wires from 1 to 12 that you have to unplug, this is the ideal way.
Cat. HM-3202

$4.95



NEW'88

Thermal/Magnetic 0.5 Amp Circuit Breakers

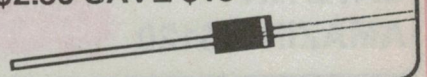
Quality made E-T-A German make. Single pole plunger type, 240V AC or 65V DC. Will interrupt when current exceeds 0.5 amp. Has thermal overload (slow current increase) and magnetic overload (fast current increase) for double circuit protection. Has 2 aux contacts (NO & NC) to trigger remote alarms if necessary.
Cat. SC-2280

Normally $4.50
SALE PRICE $2
SAVE $2.50

ZENER DIODE BARGAINS

BARGAIN No.1 12 volt 1 watt Pkt 25
Cat. ZR-1370
$2.95 SAVE $5.80

BARGAIN No.2 6 volt 500mW Pkt 50
Cat. ZR-1372
$2.50 SAVE $10



Flashing LEDs

All 5mm, 3-5 volt operation. Pulse rate 2Hz, 1.2mCd at 3 volts.
Available in 3 colours

RED	Cat. ZD-1730
GREEN	Cat. ZD-1731
YELLOW	Cat. ZD-1732

$1.50 ea 10+ $1.35 ea

PC Mount LEDs

Incorporates a 5mm LED in a plastic bezel for PC mounting.
4 colours

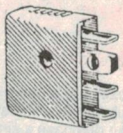
RED	Cat. ZD-1780
GREEN	Cat. ZD-1781
YELLOW	Cat. ZD-1782
ORANGE	Cat. ZD-1783

48¢ each 10+ 42¢ each

TELEPHONE PLUG BARGAIN

SAVE 50%

without the cable grommet.
NORMALLY $3.95
Limited quantity
Cat. PP-1400



ONLY $1.95 ea
10 up $1.75 each

DIRECT IMPORT light duty HOOK-UP WIRE ON 25 metre ROLLS

Now all hobbyists can afford to have a roll of each colour hook-up wire by their workbench. Quality 13/0.12 tinned hook-up wire on plastic spools.

Red	Cat. WH-3000	Yellow	Cat. WH-3004
Black	Cat. WH-3001	Green	Cat. WH-3005
Brown	Cat. WH-3002	Blue	Cat. WH-3008
Orange	Cat. WH-3003	White	Cat. WH-3007

$3.95 per reel

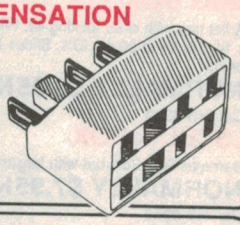
Buy one roll of each colour - 8 rolls in all for only $25.95
8 pack Cat. WH-3009

41256 - 256k RAM 120nS

At the time of going to press we have heaps of these available ex-stock. The price is pretty ridiculous, but we have checked and we are the cheapest supplier of these ex-stock. Unless someone buys the lot (which could easily happen) we will have stock when you read this.
The price. . . are you sitting down. . .
$25 each 10+ $23.50 each
Cat. ZZ-8435

TELEPHONE DOUBLE ADAPTOR SENSATION

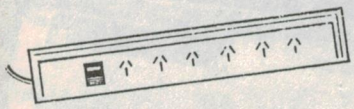
WAS $7.95
SAVE 47%
Cat. XT-6020
$3.95 ea



6 WAY POWER OUTLET WITH MAINS FILTER

Not only is it a 6 way power board, it incorporates a voltage surge and spike protector and noise rejection filter network. Supplied with two metre cord and mains plug, safety shutters on each outlet, illuminated master on/off switch and even a safety circuit breaker.
Cat. MS-4030
$59.95

NOTE: If you require absolute mains suppression don't forget our Australian made Squeeky Clean Mains Filters.



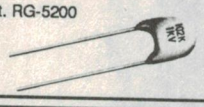
FUEL CUTOUT SOLENOID

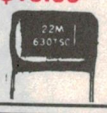
Who needs a noisy car alarm, after you have installed one of these in your vehicle. It's operated from a hidden switch. Simply turn it on when you leave your car, and if your car is stolen, it won't go very far without any petrol. Supplied with instructions, pre-wired switched, hardware and even two alarm stickers. Quality M&D Alarm brand. Add to this our deluxe red light flasher kit - KJ-7000 $19.95, and who needs an alarm?
Cat. XC-2050
$69.95

HIGH VOLTAGE CAPACITOR PACK

This is rare. Attention servicemen. We can offer you a bag of over 175 pcs of both high quality Polycarbonates and ceramic capacitors. Many of these are from current colour TV manufacturers surplus. Limited quantity, and probably will never be repeated. (We rarely see high quality high voltage caps anymore).
Here's what you get:
Polycarbonate
We have many different values in small quantities so most bags will be different. Higher quantities include: 0.0056, 0.047, 0.068, 0.056, 0.1, 0.18, 0.22, 0.27, 0.33, 0.56, in voltages 200V, 400V, 630V, 1.5kV, 1.6kV, 2kV
Ceramic:
Include a good range of values. 100pF, 220, 270, 330, 470, 500, 680, 1000, 2200, 4700pF in voltages 400V, 500V, 1kV, 2kV and 3kV.

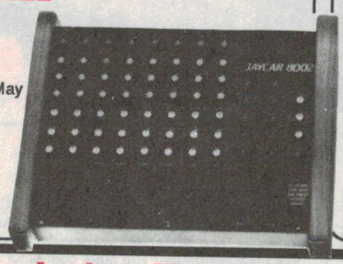
DON'T MISS OUT!! LIMITED QUANTITY!! WON'T LAST OVER 175 CAPS FOR $10.00
Cat. RG-5200





8 CHANNEL AUDIO MIXER

Ref: EA April/May 1983
Cat. KJ-6504
$595
Pictured with optional desk console



TV COLOUR BAR PATTERN GENERATOR

Ref: EA October 1987
Will provide 8 different patterns and colour bars. Power Pack to suit Cat. MP-3020 $14.95
Cat. KA-1691 **$149**

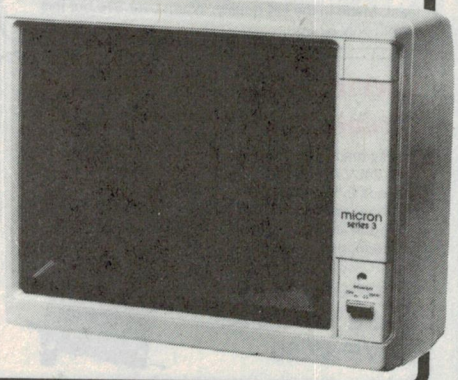
BARGAIN RF CHOKE PACK

Over 50 pieces supplied!
A pack of 30 brand new RF chokes with at least 14 different values! Popular values include: 1.5, 4.7, 12, 15, 18, 22, 68, 100 & 1000uH. Each choke is resin dipped and colour coded (they look like bead tantalums). A colour coding chart is supplied so that you can decipher the value.
BONUS! Not only do you get 30 useful chokes we will give you at no extra charge at least another 30 more RF chokes! These are genuine chokes but are commonly called 'peaking coils'! They look like a 1/2 watt resistor. (Read the choke value in uH as you would a resistor value).
Cat. RC-5600 **WAS $10.00 NOW $5**

Micron Amber Monitor Sensation - Below 1/2 Price

At this price one would believe that these Micron Amber 12" monitors fell off the back of a truck! They didn't, but grab one anyway while they last - because at this price they won't be around for long. These are brand new, non-glare Series III 18MHz bandwidth, 900 resolution line quality amber monitors.
See our 1988 catalogue for full details.
Cat. XM-4500
CATALOGUE PRICE $229.50
NOW ONLY $109.50
SAVE AN AMAZING $120

DIRT CHEAP!!



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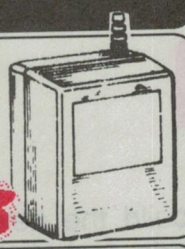
CALL GARY JOHNSTON OR BRUCE ROUTLEY TODAY ON (02) 747 2022.

GORE HILL OPEN 'TIL 4 pm SATURDAY

NEW KIT FOR SEPTEMBER
Speakerphone ONLY $89

Ref: Silicon Chip Sept. 1988
High quality hands free telephone adaptor that works extremely well.
Full kit including box, panel, isolating transformer and all parts.
Cat. KC-5040

1/2 PRICE PLUGPACK
6 volts DC 300mA
NORMALLY $14.95
NOW ONLY $7.50
Cat. MP-3008



DIRT CHEAP!!

AT LAST!!

Jaycar 12V/300VA SINE WAVE Inverter

NOW AVAILABLE

Now you can enjoy SINE WAVE power at AROUND 85% EFFICIENCY for much the same cost as inferior square wave - and this unit gives a genuine 300VA, not less.
The Jaycar Sine Wave Inverter has tremendous surge capability. It will, for example, start a small refrigerator.
We are very proud of this Australian made and designed product. The price, however, may have to rise soon, so hurry!
Cat. MI-5020
$399

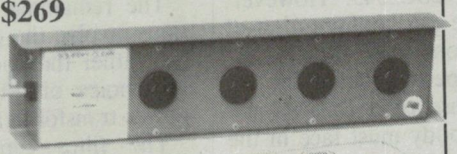
NEW '88

SQUEAKY CLEAN MAINS FILTERS

MADE IN AUSTRALIA

Fully approved
4 OUTLET

The MS-4020 will supply up to 4 appliances. Each 240V socket is independently filtered. The filter will suppress interference from RF sources, spikes, transients and lighting, and supply up to 4 outlets with a total load of 4 amps.
Cat. MS-4020
NORMALLY $269
SAVE $40
SEPT ONLY
$229



2 OUTLET

The two outlet will handle up to 7.5 amps. The two sockets are not independently filtered although.
Cat. MS-4025
NORMALLY $99 SAVE $20 NOW $79

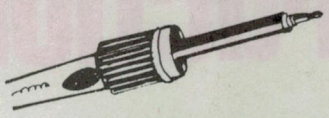
FREE SOLDER

ADCOLA SOLDERING STATION

MADE IN AUSTRALIA

Station only	$159.50	Cat. TS-1475
40W iron to suit	$49.95	Cat. TS-1478
80W iron to suit	$55.00	Cat. TS-1480

Purchas a station and one iron together and receive a FREE 200g roll of solder and a roll of desolderwick - worth $9.45



ADCOLA 240V IRONS

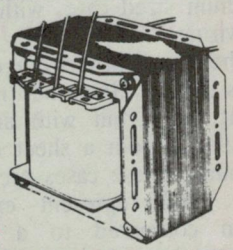
FREE DESOLDERWICK

S30 12 watt $36.95 Cat. TS-1492
S50 16 watt $39.95 Cat. TS-1494

Purchase either of these irons and receive a FREE roll of desolderwick - worth $2.50

TRANSFORMER BARGAIN

This 100VA unit measuring 100(H) x 90(W) x 75(D)mm features a mounting bracket that enables you to mount it vertical or on its side. Primary winding is tapped from 200-240 volts. Secondaries are 1 x 16V, 1 x 12V. Both would be minimum 2 amps.
Cat. MM-1812
$14



DIRT CHEAP!!

BARGAIN Electros

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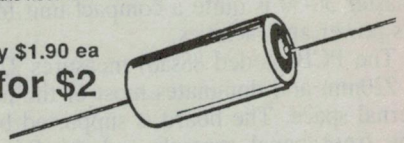

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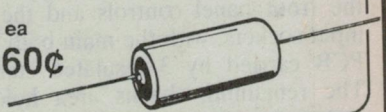

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New 30W stereo amplifier project - 3

Full details of construction

This month we'll show you how easy it is to build the new Playmaster 30-30 amplifier. Virtually all of the parts, including the heatsinks, mount on one large printed circuit board.

by ROB EVANS

As you may see from the pictures of our prototype, the assembled printed circuit board (PCB) fits neatly into a medium sized case, with very little interwiring.

The case is in fact one of the standard sizes in the "Horwood" range of instrument cases, but with an added front panel cut from a sheet of 1.5mm aluminium. These cases are readily available, and represent excellent value when compared to a suitable rack mounting case for example.

The overall box dimensions are 305 x 228 x 76mm, with a front panel measuring 325 x 80mm; this means the Playmaster 30-30 is quite a compact unit for its power and facilities.

The PCB (coded 88sa8) measures 220 x 220mm and dominates most of the internal space. The board is supported by the front panel controls and the RCA input sockets, with the main body of the PCB carried by 3 insulated standoffs. The remaining chassis area holds the power transformer, mains wiring, and loudspeaker connectors.

Components

Before discussing the assembly procedure for the Playmaster 30-30, we need to consider a few component choices which will effect the performance and cost of the unit. These choices mainly involve components in the phono preamp, so you may wish to consider if records are your prime listening source, or compact discs and other "line" inputs monopolise your listening time.

Naturally, if you rarely use the phono facility, the extra expense of higher quality components is unnecessary; particularly since this stage delivers quite a creditable performance in its standard form. However, if it's even higher performance you are seeking, the changes are simple.

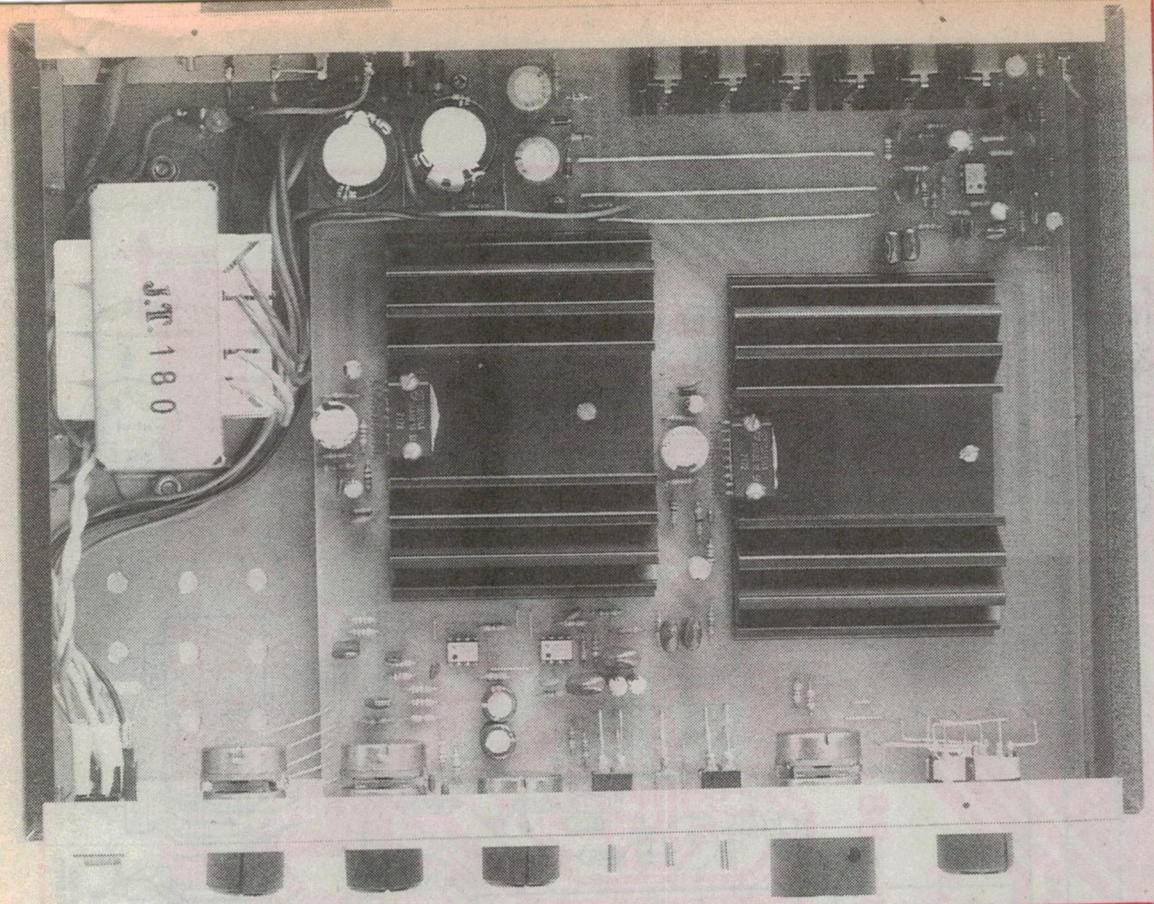
The TL072 op-amp in the phono stage may substituted by an LM833 for example. This is a wide bandwidth low noise device which is pin for pin compatible with most dual op-amps, and will slot directly into the existing circuit. Also, the transistors which form the input differential pair (Q1 and Q2) could be changed for more exotic devices, such as the low noise 2SC2545. However, carefully check the pin configuration of alternative transistors. For example, the 2SC2545 pins happen to be in the reverse order to those of a BC549, and when installed its body must face in the opposite direction to that as shown in the component overlay.

Another refinement of the phono preamp's performance is to include close tolerance components (1% or 2%) in the RIAA feedback network, including R8 to R10 and C5 to C7. This will ensure that the frequency response on the phono input will at least match the accuracy of our prototype, which tracked the RIAA curve within +/- 0.5dB.

At this point you may also wish to consider if the CD attenuating resistors are required. If you have a CD player with a nominal output of around 2 volts, values of 47k and 6.8k for Rx and Ry respectively should match the CD player's output to the amplifiers 250mV rating. Other attenuation levels may be easily calculated using standard voltage divider techniques.

The remaining component considerations involve the question of compatibility, rather than performance. These are the choice of filter capacitors and the power transformer.

The filter capacitors used in our prototype (5600uF 40V), are a neat fit



The neat internal layout and simple construction of the 30-30 amplifier is due to careful PCB design, and the use of integrated power amplifier ICs.

amongst the other PCB components, leaving little space for units that are physically larger. If capacitors of this size are unavailable, 4700uF 35V types should easily fit, resulting in a slight drop in the amplifier's maximum output power. Alternatively, extra space could be generated by juggling the position of the mounting holes, and physically larger capacitors of the specified value installed.

The power transformer for this amplifier must have a secondary voltage of 22-0-22 volts or less, due to the maximum voltage limitations of the TDA1514A chips. Depending on the rating method of the manufacturer, a 22-0-22 volt transformer may have a secondary voltage as high as 25-0-25 volts when lightly loaded. This would produce supply rails of about +/-35 volts, which significantly exceeds the +/-30 volt maximum rating of TDA1514A chips. The power transformer chosen for the Playmaster 30-30 amplifier *must not* produce supply rails that exceed this +/-30 volt rating, or the power ICs may be damaged.

Fortunately, the suitability of a transformer may be easily tested by measuring its off-load secondary voltage, which should be about 22-0-22 volts or less. In fact, a conservatively rated 20-0-20 volt transformer may be quite appropriate, since its off-load voltage would be around the required 22-0-22 volts. These voltage levels will depend on the local mains voltage, which should be taken into consideration during these measurements and the initial amplifier testing. Note that the published performance specifications of our prototype were achieved with a 22-0-22 volt, 1.5 amp transformer labeled JT180.

Wiring the PCB

The first step before installing components on any PCB, is to check the pattern for anomalies such as broken or bridged tracks. Also check the various bolt holes for correct sizing; it's much easier to re-drill them now, rather than dodging components later.

Begin the actual assembly by mounting the lower profile parts first while carefully following the component overlay, noting component positions and polarities (if applicable). Start with the links and work your way through to the larger components. There are 10 links on the PCB, including three long connections between the power supply and the phono stage; these should be constructed from insulated wire which will prevent contact with other components.

All of the resistors may mount flush with the PCB, except those with a higher power rating. These resistors are numbered R28 to R33, and should be positioned slightly above the board to assist their cooling. The larger capacitors should also mount flush with the PCB to provide maximum mechanical stability (note that the main filter capacitors have a third mounting pin).

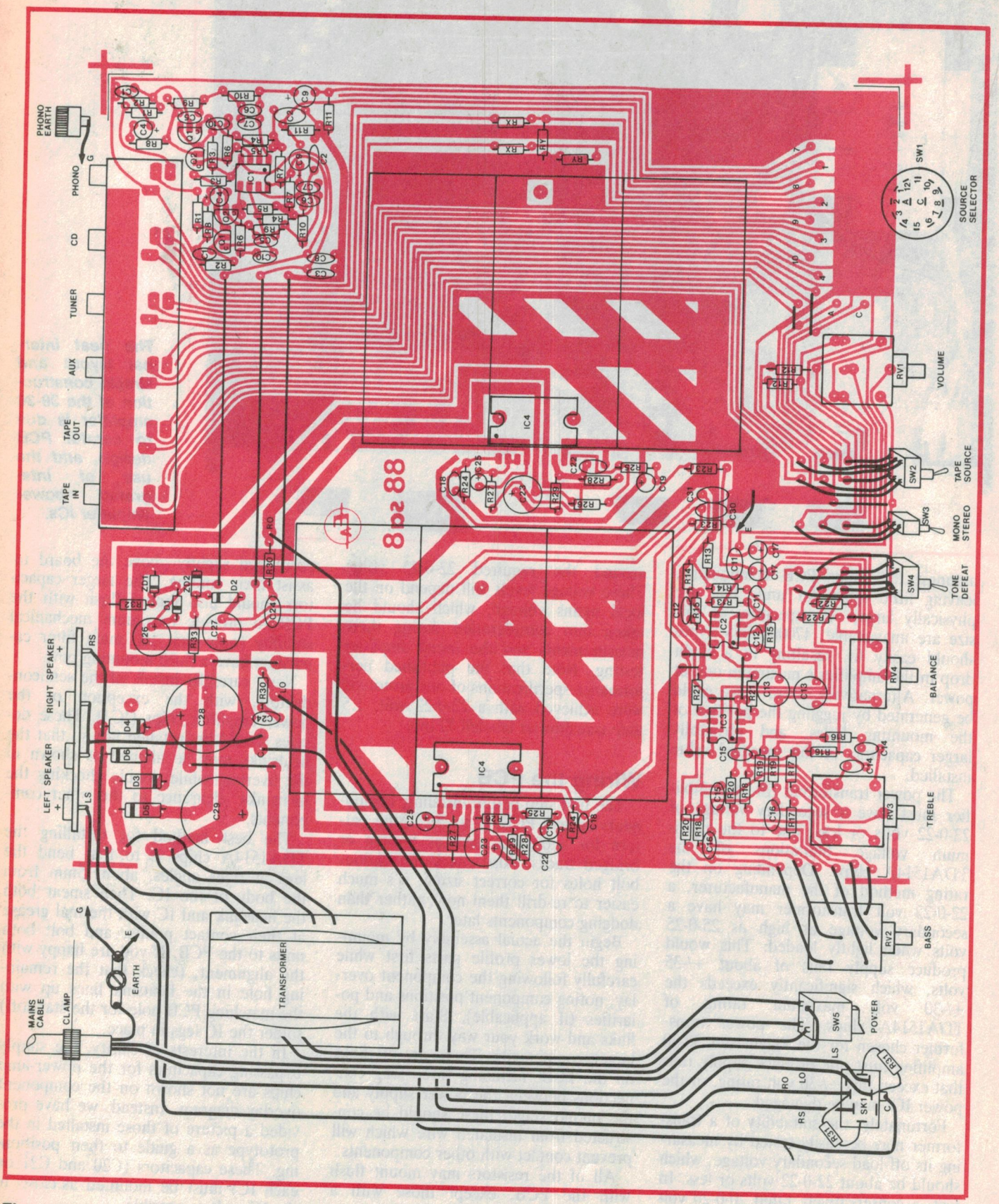
Next, carefully install all the semiconductors, with the exception of the power amplifier chips (IC4). These devices should be installed last so that the heatsinks may be aligned as shown in the overlay, while double checking the heatsinks' clearance to the other components.

The best method for installing the TDA1514A chips is to first bend the legs at right angles, about 5mm from the body of the IC. Then smear both the heatsink and IC with thermal grease at their contact points, and bolt both units to the PCB. If you are happy with the alignment, (check that the remaining hole in the heatsink lines up with the matching PCB hole for the standoff) solder the IC legs in place.

In the interests of clarity, the supply bypassing capacitors for the power-amp chips are not shown on the component overlay diagram. Instead, we have provided a picture of those installed in the prototype as a guide to their positioning. These capacitors (C20 and C21 on each IC) must be mounted as *close* to the IC pads as possible.

Don't forget these capacitors, because

30W stereo amplifier



The component overlay and wiring diagram. The PCB pattern and front and rear panel artwork are too large to reproduce on these pages, however copies may be ordered through the EA Reader Services section.

the high bandwidth and slew rate of the TDA1514A chips may induce some instability if they are omitted.

The next step is mounting the potentiometers, switches and RCA sockets, all of which locate the PCB within the box. The pots should be temporarily mounted on the PCB (not soldered in place), so that the mounting points may be compared to the box dimensions, which tend to vary from unit to unit. The PCB has been designed so that the distance between the RCA sockets and the pots threads is slightly shorter than the depth of the specified box. This allows room for adding spacers to the pot shafts, making the whole assembly a neat fit within the box. By measuring the distance on the PCB assembly (in its temporary form), we can decide how many spacers are required or if the pot legs need to be bent either way.

If the pot shaft threads are too short for the required number of spacers, you may need to leave a small gap between the RCA sockets and the rear panel in the final assembly stage. This won't significantly restrict access to the RCA sockets, and prevents the need for any component repositioning. When calculating this spacing, remember to include the small dimension added by the front panel.

Finally, remove the pots and cut the shafts to match the depth of the knobs. Then re-install the pots and solder them in place, while double checking their vertical alignment with a ruler. Install the remaining components, while carefully referring to the component overlay diagram. The switches and bass pot are attached to the PCB by short tinned copper wire stalks', which may be trimmed or aligned after the PCB assembly has been installed in the box.

Preparing the box

If the "Horwood" style of box is to used to house the Playmaster 30-30, the front dress panel will need to be attached before installing any electronics. On our prototype, this was located by 4 countersunk bolts to maintain an even surface for the addition of a "Dynamark" (or Scotchcal) panel. The mounting holes in the front and rear panels should be drilled using the panel artwork as a guide, while double checking each component for a neat fit.

Check that the headphone socket has enough thread to clear both the box front panel, and the additional dress panel. If more thread is required to install the locking nut, enlarge the hole in the box front panel only, leaving the threaded bush to penetrate the single thickness of the dress panel.

Next, temporarily install the PCB assembly in the box to serve as a guide for the remaining holes and components. With the bottom panel in place, mark the holes for the transformer, earth lug and PCB supporting spacers. When drilling these holes, take the opportunity to prepare the panel fixing screw holes around its perimeter.

The top and bottom box panels will need to be perforated with a number of holes. This will allow air to flow through the box, cooling the PCB mounted heatsinks. Drill as many holes as your patience will allow – it's better if the heatsinks are over-cooled than under-cooled. However, avoid the transformer mounting area on the bottom panel, as too many holes may cause the metal to flex due to the substantial weight of the transformer.

With the PCB assembly removed, the next step is to attach the front and rear "Dynamark" panels. This can be a little tricky since Dynamark panels must be aligned correctly on the first attempt; they cannot be removed without being damaged.

A successful method for aligning these panels is to first pierce small holes to mark the centre of the panel holes or cutouts. Then tape the panel face down on a smooth flat surface (make sure this surface won't scratch the artwork), with the protective backing paper removed. The box panel may then be carefully pressed onto the Dynamark panel using the holes as a guide. Then trim the artwork to size with an art knife or scapel.

The PCB assembly may now be permanently installed in the box, but leave the top and bottom panels off for the moment so the final wiring may be completed.

Final assembly

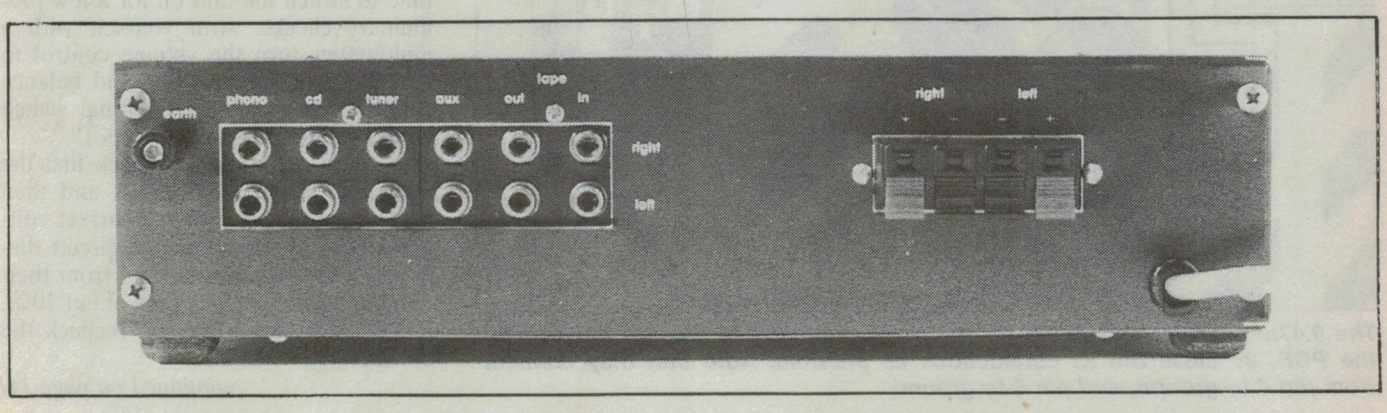
These final stages are quite straightforward since most of the amplifier's wiring is an integral part of the PCB. The remaining wiring carries the mains power and speaker signals.

Before commencing any wiring, the supporting spacers should be screwed to the PCB with extra washers used to increase their length. This length may be checked with a ruler held where the bottom panel normally lies. Note that these spacers must be of the insulated type, because the mounting face of the power ICs, and therefore the heatsinks, are connected to the negative supply rail. Also, before bolting the mains earth lug in place, its mating surface on the bottom panel should be cleaned with a file or sandpaper to ensure a reliable contact.

Begin the final wiring by connecting generous lengths of heavy gauge hookup wire to the four speaker pads on the PCB. Also connect lengths of wire to the PCB central earthing point (on the underside of the board near C30 and C31) and the phono earthing post. The latter wires may lay under the PCB when finally connected to the chassis earth lug.

Note that one of the two leads coming from the two "common" speaker pads on the PCB connects to the headphone socket, while the other connects to both negative speaker terminals.

To connect the power transformer's secondary leads lay the box on its side, place the transformer loosely inside and solder the wires to the appropriate



pads. Pay particular attention to these wires; they should be cleaned and carefully soldered so as to avoid dry joints, and the two inner connections taken to the common pads for a centre-tapped configuration.

The bottom panel may now be screwed in place, the transformer secured and the remaining wires connected. Once again, refer to the component overlay for the earth connections, the speaker/headphone wiring and mains connections. Note that the headphone socket must be of the insulated switching type, and the *normally closed* contacts are used.

The mains wiring at the power switch terminals *must be insulated* with protective sleeving, and the cable solidly locked with a cable clamp at the box entry point. Also ensure that the green/yellow lead of the mains cable is connected to the earth lug.

The "Horwood" style box has a metal bottom panel which may tend to vibrate due to the power transformer's electrical influence. This may be cured by inserting a thin rubber or plastic spacer under the transformer's main body, to hold the panel firmly in place. However, make sure the mounting tags remain directly connected to the panel; this will maintain continuity to the transformer's frame and electrical shield. At this stage, it may be worth checking the transformer, pots, switches, and all box panels for continuity to the earth lug.

The test flight

Now that the amplifier is completed, it's worth spending a few extra minutes to double check the wiring and component orientation against the overlay diagram. Pay particular attention to the orientation of the semiconductors and polarised capacitors.

PARTS LIST

1 printed circuit board, code 88sa8, 220 x 220mm
1 box, 305 x 76 x 228mm
2 heatsinks, 75 x 105mm
1 power transformer, 22-0-22VAC at 1.5A (see text)
1 4-way spring push speaker terminals
2 3 x 2 way PC mount RCA sockets
1 4mm binding post (black)
4 rubber feet
1 stereo insulated 6.5mm socket, with DPDT contacts
1 DPDT illuminated miniature rocker switch (mains rated)
2 DPDT miniature toggle switches
1 SPDT miniature toggle switch
1 2-pole 4-position sealed rotary switch
4 22mm black anodised knobs
1 30mm black anodised knob
1 mains cord clamp
1 mains cord and plug
1 earth lug
3 15mm tapped insulated standoffs

Semiconductors

2 Philips TDA1514A power-amp ICs
3 TL072 op-amps (see text)
4 BC549 NPN transistors (see text)
2 15V 1W zener diodes
2 1N4002 diodes
4 1N5404 power diodes

Capacitors

2 5600uF 40V PCB mount electrolytics
2 1000uF 16V PCB mount electrolytics
2 220uF 63V PCB mount electrolytics
4 33uF 16V PCB mount electrolytics
2 10uF 63V PCB mount electrolytics
2 6.8uF 50V PCB mount bipolar electrolytics
4 1uF 16V PCB mount electrolytics
4 0.47uF 100V metallised polyesters
2 0.15uF 100V metallised polyesters
6 82nF 100V metallised polyesters
2 39nF 100V metallised polyesters
4 22nF 100V metallised polyesters
2 4.7nF 100V metallised polyesters
4 3.9nF 100V metallised polyesters
2 3.3nF 100V metallised polyesters
2 1.5nF 100V metallised polyesters
4 1nF 100V metallised polyesters
2 390pF ceramics
2 100pF ceramics

Resistors (all 0.25W, 5% unless noted)

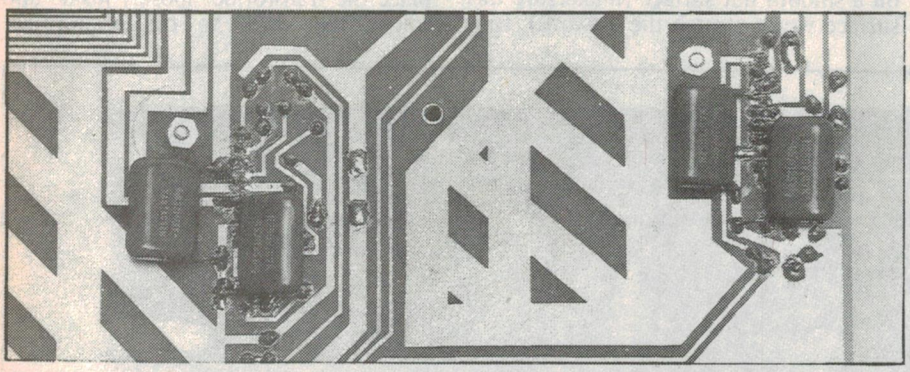
2 x 820k, 2 x 680k, 2 x 270k, 2 x 150k, 2 x 82k, 2 x 68k, 2 x 56k, 2 x 47k, 6 x 27k, 6 x 15k, 2 x 12k, 2 x 10k, 2 x 5.6k, 2 x 4.7k, 4 x 3.9k, 4 x 2.7k, 2 x 1.2k, 2 x 820 ohms (0.5W), 2 x 680 ohms, 2 x 330 ohms (0.5W), 2 x 220 ohms (0.5W), 2 x 120 ohms,
2 x 47 ohms (0.5W), 2 x 6.8 ohms (0.5W)

Potentiometers

1 PC mount dual gang 100k linear
1 PC mount dual gang 50k log
1 PC mount dual gang 25k linear
1 PC mount single gang 25k linear

Miscellaneous

hookup wire, nuts and bolts and washers, heatsink compound



The 0.47uF stability capacitors for the power amplifier ICs mount underneath the PCB, as close the IC connections as possible. Note that they connect from pin 4 to ground, and pin 6 to ground.

If you are satisfied that all is well, it's time to switch the unit on for a few preliminary checks. Arm yourself with a multimeter, turn the volume control to minimum, centre the tone and balance controls, and select the normal switch modes (all toggle switches "up").

Switch on, and quickly check first the main DC power supply rails and then the pre-amp supply for the correct voltage levels, as shown on the circuit diagram. If the readings deviate from their nominal value by more than about 10%, immediately switch off and recheck the circuit.

continued on page 141

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	Comp Strips	Distribution Strips			
540	1	2		B212P	$22.85
3160	4	8			
	plus UC-02 edge plate			UIB46	$92.50
2320	3	4			
	plus UC-02 edge plate			UIB34	$126.50

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32way DIN41612 - 5.08mm	UC05-3	$20.65
64way DIN41612 - 2.54mm	UC05-6	$25.90
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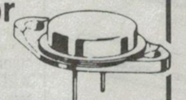

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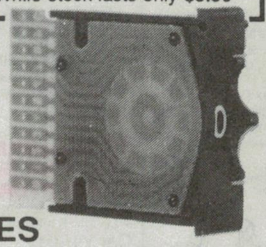

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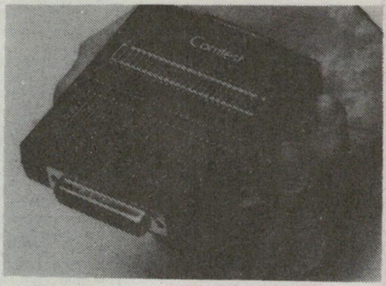

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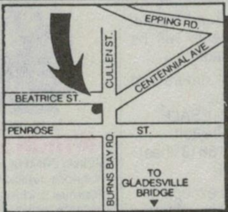

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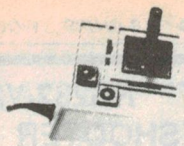

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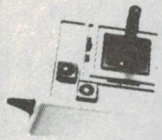

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These joysticks have adaptor connectors to suit the Apple II, IIc. IIe and II+ computers. Features include selectable "spring centring" or "free floating". Electrical trim adjustments on both axis. 360° cursor control and dual fire buttons

C14201 ..... **only $39.95**

APPLE* COMPATIBLE JOYSTICK

Ideal for games or word processing. Fits most 6502 "compatible" computers.

Cat. C14200 ..... **$39.95**

rie

ROD IRVING ELECTRONICS

MELBOURNE: 48 A'Beckett St.
Phone (03) 663 6151

NORTHCOTE: 425 High St.
Phone (03) 489 8866

CLAYTON: 56 Renver Rd.
Phone (03) 543 7877

MAIL ORDER & CORRESPONDENCE:
P.O. Box 620, CLAYTON 3168
Order Hotline: 008 33 5757
(Toll free, strictly orders only)
Inquiries: (03) 543 7877
Telex: AA 151938
Fax: (03) 543 2648

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(TOLL FREE)

STRICTLY ORDERS ONLY

LOCAL ORDERS & INQUIRIES
(03) 543 7877

POSTAGE RATES:

$1 – $9.99	**$2.00**
$10 – $24.99	**$3.00**
$25 – $49.99	**$4.00**
$50 – $99.99	**$5.00**
$100 plus	**$7.50**

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

All sales tax exempt orders and wholesale inquiries to:
RITRONICS WHOLESALE,
56 Renver Road, Clayton.
Phone: (03) 543 2166 (3 lines)
Fax: (03) 543 2648

Errors and omissions excepted. Prices and specifications subject to change.

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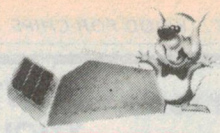


WITTY MOUSE

- Three buttons, user definable. Get the maximum selective features possible by having a third button choice.
- A specially silicone coated steel ball transfers mouse movement to internal motion encoders without the need of a special surface. Smooth gliding over any hard, even surface.
- High resolution movement of 195 dots/inch. This means you can work with a smaller table space with less hand movement than a lower resolution mouse.
- Optical rotary encoder
- Max. tracking speed: 200m/sec
- Mouse resident firmware
- Auto repeat key
- 1·5 metre lead
- DB25 socket connector
- Weight: 212 grams
- Size: 116 x 66 x 34mm

Cat.X19950 ..... **$59.00**

NOTE: HARDWARE ONLY. SOFTWARE NOT INCLUDED

8087

Genuine Intel chips with manual and data sheets packed in boxes!

8087-3 (4.77MHz)	**$195**
8087-2 (8MHz)	**$295**
8087-1 (10MHz)	**$395**
80287-6 (6MHz)	**$349**
80287-8 (8MHz)	**$499**
80287-10	**$549**
80387-16	**$899**
80387-20	**$1499**
80387-25	**$1799**

SCHMIDT 123AT MULTI STANDARD MODEM

- V21, V22, V23 Multi standard modem (300/300, 1200/1200, 1200/75)
- Auto dial "AT" command set (Hayes* compatible)
- Auto answer/auto disconnect
- Auto answerback (Similar to Telex)
- Auto or manual control
- Dial-up or leased line operation
- Pulse or Tone Dialing
- Automatic speed ranging
- Speaker for call progress monitoring
- Baud-rate converter with 48 character buffer (V23)
- Synchronous or asynchronous operation
- Fully self contained power supply
- Low power operation
- Metal case (R.F. shielded)
- Visual monitoring of important interface circuits (7 LED's)
- Full or half duplex (V23)
- Double adaptor plug to allow use of standard phone (Mode 1/3/5)
- Telecom Authorised (C87/37/65)

..... **$595**

*Hayes is a trademark of Hayes Microcomputer Products Inc.

TELEPHONE ADAPTOR

- Australian plug to U.S. socket
- Length 10cm

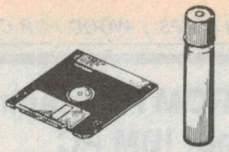
Cat. Y16026 ..... **$5.95**

RITRON 2 MONITORS

Stylish 20MHz, non-glare 12 inch monitors available in green or amber displays and featuring swivel base that tilts forward and back and swivels right to left!

Green (X14506) . **Normally $179**
Amber (X14508) . **Normally $179**

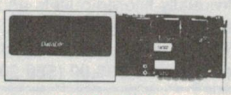
SPECIAL, ONLY $149



HEAD CLEANER DISKS

It only takes a minute amount of dust, dirt or magnetic oxide particles on your drive heads to cause problems: errors, downtime or an expensive service call. Regular use of a head cleaner will keep your drive free of trouble causing dirt and help keep your system up and running. These disk cleaners are simple to use, and include cleaning solution and instructions.

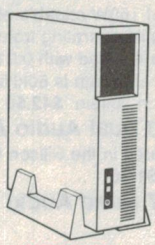
CAT.No.	SIZE	PRICE
C12560	3½"	**$6.95**
C12555	5¼"	**$6.95**



VERBATIM HARD DISK CARD

Available 20 or 30 M/Byte! IBM* compatible, plugs straight in to your computers bus connectors!

X20020 20 M/BYTE ... **$695**
X20030 30 M/BYTE ... **$895**



VERTICAL COMPUTER STAND

FREE VALUABLE DESK SPACE OF YOUR PC BY PLACING IT ON ITS SIDE ON THE GROUND!

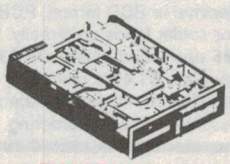
- Adjustable width from 115-188mm (4¼"-7¼")
- Accomodates IBM*PC/XT/AT and most compatibles
- Light weight, durable construction

C21076 ..... **$24.95**

TELECOMMUNICATIONS AUSTRALIAN TO U.S. ADAPTOR CABLE

- Australian socket to U.S plug.
- Length 5 metres.

Cat.Y16017 ..... **$7.95**



FUJITSU 5¼" 1·2 M/BYTE DISK DRIVE

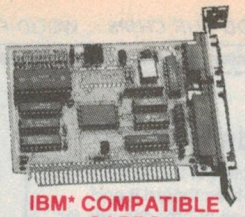
Quality at an affordable price! 5¼" Double sided, double density. 1·2 M/Byte unformatted, 720K formatted. IBM* AT* compatible.

C11906 ..... **ONLY $249**

FUJITSU 3½" DISK DRIVE

Affordable quality. Double sided, double density drive. 1 M/Byte unformmatted, 640K formatted. Access time 3 m/sec.

C11905 ..... **ONLY $255**



IBM* COMPATIBLE CARDS

XT* 8MHz TURBO MOTHERBOARD
X18030 Excluding RAM **$169**
X18031 Including 640 RAM.. **$699**

XT* 10MHz TURBO MOTHERBOARD
Excluding RAM **$199**
Including RAM **$749**

BABY AT* MOTHERBOARD
X18200 Excluding RAM **$689**
X18201 Including 640 RAM **$1,299**

AT* 6/10MHz MAINBOARD
X18100 Excluding RAM **$689**

386 MAINBOARD
X18101 Excluding RAM .. **$2,489**
X18103 Including 1 M/Byte **$3,495**
X18105 Including 2 M/Byte **$4,495**

TTL GRAPHICS CARD
X18003 ..... **$139**

E.G.A. CARD
X18070 ..... **$195**

COLOUR GRAPHICS CARD
X18002 ..... **$99**

COLOUR GRAPHICS & PRINTER CARD
X18010 ..... **$99**

PRINTER CARD
X18017 ..... **$29**

MULTI I/O & DISK CONTROLLER
X18040 ..... **$145**

768K MULTIFUNCTION I/O CARD
X18050 Excluding RAM **$194**

MULTI SERIAL CARD
X18154 ..... **$139**

16 BIT FLOPPY DISK DRIVE CONTROLLER CARD
X18005 (2 DRIVES) **$52**
X18006 (4 DRIVES) **$55**

1·2 M/BYTE - 360K FLOPPY DISK DRIVE CONTROLLER
X18008 ..... **$124**

DTC HARD DISK CONTROLLER
X18060 (XT*) **$190**
X18140 (AT*) **$290**

RS232 & CLOCK CARD
X18028 ..... **$89**

RS232 (SERIAL) CARD
X18026 ..... **$49**

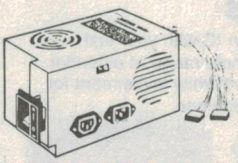
CLOCK CARD
X18024 ..... **$55**

GAMES I/O CARD
X18019 ..... **$29**

I/O PLUS CARD
X18045 ..... **$119**

512K RAM CARD
X18013 Without RAM **$99**
X18014 With RAM **$459**

2 M/BYTE RAM CARD
X18052 ..... **$194**



150W SWITCH MODE POWER SUPPLY FOR IBM* PC*/XT* & COMPATIBLE

DC OUTPUT: +5/13A, -5V/0.5A +12V/4.5A -12V/0.5A

X11096 ..... **$129**

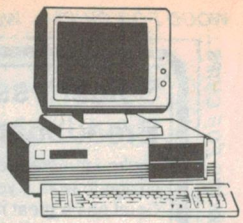
200W SWITCH MODE POWER SUPPLY FOR IBM* AT* & COMPATIBLE

DC OUTPUT: +5/16A, -5V/0.5A +12V/5A -12V/0.5A

Cat. X11097 ..... **$199**

180W SWITCH MODE POWER SUPPLY FOR BABY AT* COMPATIBLES

Cat. X11098 ..... **$189**



IBM* XT* COMPATIBLE COMPUTERS FROM $875

Check these features and our prices. We're sure you'll agree they're exceptional value for money!

- Final assembling and testing in Australia!
- Fast 8MHz TURBO Motherboard
- AT* style keyboard
- Tested by us for 24 hours prior to delivery!
- 8 Slot motherboard
- 12 months warranty!
- 150W power supply

*$875 COMPATIBLE COMPUTER

256K RAM Single Drive, Graphics and Disk Controller Card. ... **$875**

256K RAM TURBO COMPATIBLE COMPUTER

2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Parallel Port. (Includes Timer Disk) **$1,045**

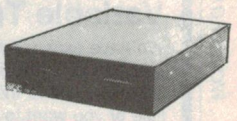
640K RAM TURBO COMPATIBLE COMPUTER

2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Serial, Parallel Port. (Includes Timer Disk). **$1,175**

WITH 20 M/BYTE HARD DISK:
& single 360K Disk Drive .. **$1,775**
& dual 360K Disk Drives .. **$1,975**

WITH 40 M/BYTE HARD DISK:
& single 360K Disk Drive .. **$2,475**
& dual 360K Disk Drives .. **$2,675**

WITH 80 M/BYTE HARD DISK:
& single 360K Disk Drive .. **$3,895**
& dual 360K Disk Drives .. **$4,095**



APPLE* COMPATIBLE SLIMLINE DISK DRIVE

Compatible with Apple 2+

Cat. X19901 . **Only $179**

APPLE* IIC COMPATIBLE DISK DRIVE

(including cable ..... **only $199**

(*Apple is a registered trade mark.)

20 M/BYTE HARD DISK

Tandon, including DTC controller card. 12 month warranty. IBM* compatible.

X20010 ..... **ONLY $549**

50 M/BYTE HARD DISK

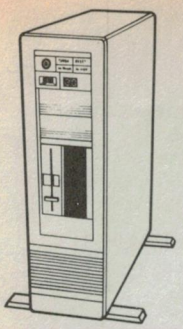
Miniscribe. 12 month warranty. IBM* compatible. 42 M/Byte formatted.

Excluding Controller **$649**

80 M/BYTE HARD DISK

Seagate, 12 month warranty. IBM* compatible.

Excluding Controller **$2,490**

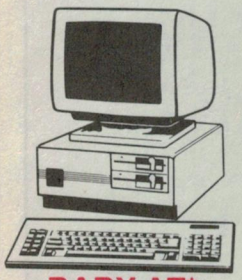


386 TOWER PC

The 386 Tower PC is a high performance system that is functionally and mechanically compatible with the IBM*AT* However, the 386 Tower PC contains a 80386 microprocessor, 32-bit memory access, and other features, giving it 2-5 times the performance.

FEATURES:
- Intel 80386-20MHz microprocessor
- Switchable 8/16/20 MHz. 8/16/25 MHz. 0 wait state.
- One 32 bit memory slot with 0 wait state.
- 2 M/Byte fitted. Total memory expandable up to 16 M/Bytes.
- Up to 2 M/Byte or 8 M/Byte RAM modules on system board or on RAM card
- Up to 2M/Byte or 8 M/Byte RAM chip on system board or on RAM card
- Option for 80287 & 80387 co-processor socket
- Operates in page mode with interleave memory subsystem
- Shadow RAM supported to allow system BIOS to be executed on system memory instead of slower EPROM
- Real time clock with on board rechargeable battery or external battery
- Four 16-bit I/O slot. Three 8-bit I/O slot, and one 32-bit memory slot.
- 8042 keyboard controller interface for AT* compatible keyboard
- Seven direct memory access (DMA) channels
- 16 interrupts
- Chips and Technology chip set
- AMI 386 BIOS/Phoenix 386 BIOS AWARD 386 BIOS (AMI fitted)
- 50 M/Byte Miniscribe hard disk. Fast access. Formatted to 42 M/Byte.
- EGA card

$5,995



BABY AT* COMPATIBLE COMPUTER! FROM $2,295

- Final assembling and testing in Australia!
- 1 M/Byte Main Board
- Switchable 8/10/12 MHz
- 1.2 M/Byte Floppy Disk Drive
- 80286 CPU
- Colour Graphics Display Card
- 8 Slots
- Floppy & Hard Disk Controller
- Printer Card and RS232
- Keyboard
- 200W Power Supply
- Manual
- 6 Months Warranty
- Size: 360(W) x 175(H) x 405(D)mm

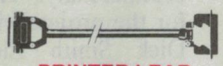
SHORT BABY AT*
512K RAM **$2,295**

STANDARD BABY AT*
640K RAM, hard disk drive....
& 20 M/BYTE HARD DISK $3,295
& 40 M/BYTE HARD DISK $3,795
& 80 M/BYTE HARD DISK $4,695

COPY HOLDER (YU-H33)

- Copy area 9½" x 11"
- Sliding line guide
- Flat metal base

C21060 ..... **$39.95**



PRINTER LEAD

- Suits IBM* PC/XT, compatibles
- 25 pin "D" plug (computer end) to Centronics 36 pin plug

P19029 (1.8 metres) **$14.95**
P19030 (3 metres) ... **$19.95**

THE BUTTON SPIKE PROTECTOR

Surges and spikes are caused not only by lightning strikes and load switching but also by other equipment being switched on and off, such as fluorescent lights, electric motors, fridge freezers, air conditioners, etc.

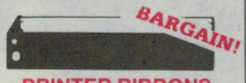
For effective protection such spikes must be stopped before they reach your equipment. Simply plug The Button into an outlet and it will protect all equipment plugged into adjacent outlets on the same branch circuit. The Button employs unique metal oxide varister technology and will dissipate 150 joules of electrical energy. (nearly twice that of comparable surge arresters.)

SPECIFICATIONS:
Voltage: 240V Nominal
Total Energy Rating: 150 joules
Response Time: 10ns
Protection Level: 350V peak
..... **$34.95**

MOUSE MAT

- A quality mouse mat for accurate and comfortable tracking
- Anti-static
- 265 x 225mm

C21075 ..... **$14.95**



PRINTER RIBBONS TO SUIT:

CP80, SX80, DP80, BX100 MB100
1-9 (C22036) 10+
$8.95 **$7.95**

MX70/80 FX70/80 RX70/80
1-9 (C22031) 10+
$8.95 **$7.95**

MX100, FX100, RX100
1-9 (C22002) 10+
$19.95 **$18.95**

LX80
1-9 (C22003) 10+
$9.95 **$8.95**

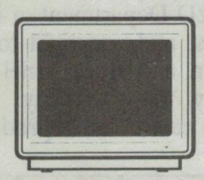
LQ1000
1-9 (C22012) 10+
$27.60 **$25.00**

THOMSON EGA MONITOR

Top quality high resolution EGA monitors with a space-age design.

SPECIFICATIONS:
CRT: 14 inch (360mm) diagonal, 90 degree deflection.
Display Size: 245(H) x 180(V)mm
Phosphor: P22, non glare, tinted screen.
Dot Pitch: 0.38mm
Video Bandwidth: 18 MHz
Resolution: 15·75KHz - 640 x 200 21·85KHz 640 x 350
Input Signals:
1. RGBI - positive, H(+), V(+)
2. RrGgBbI - positive, H(+), V(−)
Input Impedance: 330 ohms
Dual Scanning Frequency:
Horizontal: 15·75 KHz or 21·85 KHz +−10Hz
Vertical: 50 - 60 Hz
Connector: 9 pin, D-type
Size: 312(H) x 363(L) x 380(W)mm
Weight: 10·8 Kg (Net)

X14525 ..... **$695**
EGA CARD **$195**

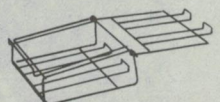


Z-DIN 12" TTL MONITOR

X14500 (GREEN) . **$139**
X14502 (AMBER) . **$139**
10 OR MORE $129 EACH

Z-DIN 12" 20MHz COMPOSITE MONITOR

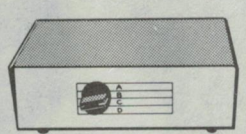
X14514 (GREEN) . **$119**
X14516 (AMBER) . **$119**
10 OR MORE $109 EACH



PRINTER STANDS

- Restores order to your work area.
- Conveniently stacks paper printout in document tray automatically
- Made of black plastic coated steel
- Suitable for most printers (80/132 column)
- Excellent value at these prices!

C21054 ..... **$26.95**



DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

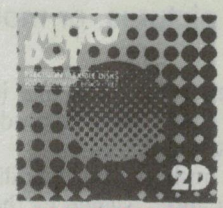
2 WAY RS232 X19120
..... **ONLY $49**
4 WAY RS232 X19125
..... **ONLY $59**

2 WAY Centronics .....
X19130 ..... **ONLY $49**
4 WAY Centronics .....
X19135 ..... **ONLY $59**

VERBATIM DISK SPECIALS!

ALL PRICES PER 10 DISKS

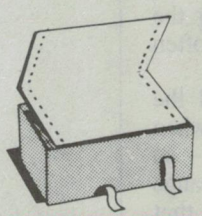
DESCRIPTION	1-9 boxes	10+ boxes
3½" 1S/2D	**$39.95**	**$37.95**
3½" 2S/2D	**$46.95**	**$43.95**
3½" 2S/HD	**$99.00**	**$89.00**
5¼" 1S/2D	**$22.00**	**$21.00**
5¼" 2D/2D	**$26.00**	**$24.00**
5¼" 2S/4D	**$75.00**	**$70.00**
5¼" 2S/HD	**$41.00**	**$39.00**



MICRODOT DISKS!

FREE PLASTIC LIBRARY CASE WITH EVERY 10 DISKS!

DESCRIPTION	1-9 boxes	10+ boxes
3½" 2S/2D	**$32.95**	**$30.95**
5¼" 1S/2D	**$11.95**	**$10.95**
5¼" 2S/2D	**$13.95**	**$12.95**
5¼" 2S/HD	**$29.95**	**$27.95**



COMPUTER PAPER

Quality paper at a low price!
2,000 sheets of 70 gsm bond paper.
C21003 11 x 9½" **$39.95**
C21005 15 x 11" . **$67.95**

PANASONIC KX-P1081 DOT MATRIX PRINTER

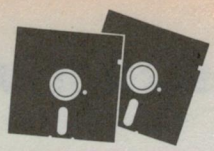
- 120 C.P.S.
- Pica or Elite character set
- Print Modes: NLQ, Dot Graphics, Draft, Proportional Font.
- Reliable and Compact
- Proportional Printing
- Logic Seeking
- 1K Printer Buffer

C20035 . Normally $595
We won't be beaten! **only $379**

DELUXE PRINTER STAND

- Restores order to your work area without occupying extra space.
- Feeds and refolds paper under the printer automatically.
- Adjustable paper deflectors to ensure smooth flow of paper.
- Made of moulded plastic
- Suitable for most printers

C21058 80 column **$89.95**



"NO BRAND" DISKS

Now you can buy absolute top quality disks that are probably the cheapest in Australia! They even come with a lifetime warranty! So why pay 2-3 times the price for the same quality?

Packs of 10, 2S/2D without boxes, or brand name, just their white paper jacket, and index labels.
(5¼" disks includes write protects).

5¼" 2S/2D DISKS

10 - DISKS	100 - DISKS	1,000 - DISKS
$6·95ea	**$6·75ea**	**$6·50ea**

(ALL PRICES PER 10 DISKS)

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$27·95ea	**$26·95ea**	**$25·95ea**

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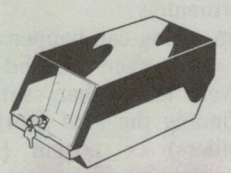
3½" 2S/2D DISKS

10 - DISKS	100 - DISKS	1,000 - DISKS
$27	**$26**	**$24**

(ALL PRICES PER 10 DISKS)



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- Smoked plastic hinged lid
- Lockable (2 keys supplied)
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- High impact plastic base
- Contemporary design

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RODIRVING ELECTRONICS

Construction project:

Low cost Stud Finder

Here's a very low cost and easy to build little unit that will indicate the position of wooden studs and noggins inside walls clad in the usual gypsum board or fibro. Build it up to take the guesswork out of hanging pictures, or mounting shelves...

How many times have you wanted to hang a picture and found that the hook you hammered into the wall missed the stud behind? Gypsum board and fresh air don't provide a very secure mounting, unfortunately.

The same thing can happen with shelf brackets. You need a solid base for these, even more than with picture hooks. Finding the stud (upright framing members) or noggin (horizontal bracing members) is almost essential, and the old trick of tapping along the board with your cranked finger often isn't accurate enough.

It can also be important to find the positions of the studs and noggins when you want to run electrical wiring – so you can avoid them, or at least arrange your run to minimise the number that will need to be drilled.

Here is the answer. A simple but effective build it yourself tool. It's easy to assemble and can be constructed in a couple of hours.

It provides two forms of indication. A light emitting diode (LED) in the centre position of the sensor changes brightness with variations in the dielectric material beneath. At the same time a piezoelectric transducer produces an audible output that varies from a ticking sound to a constant tone, depending on the density of the material under the sensor head.

In use, the sensitivity control is adjusted with the Stud Finder placed on the wall or other medium to be scanned. Take the following example: We have a plaster or gypsum board wall on which to hang a large picture frame. Two uprights are required to support the hooks. Simply place the Finder on the wall and adjust the control until the tranducer just starts to tick. Sweep the finder across the surface and bingo! – there will be a distinct change in sound and LED brightness, reaching a peak over the hidden stud or noggin.

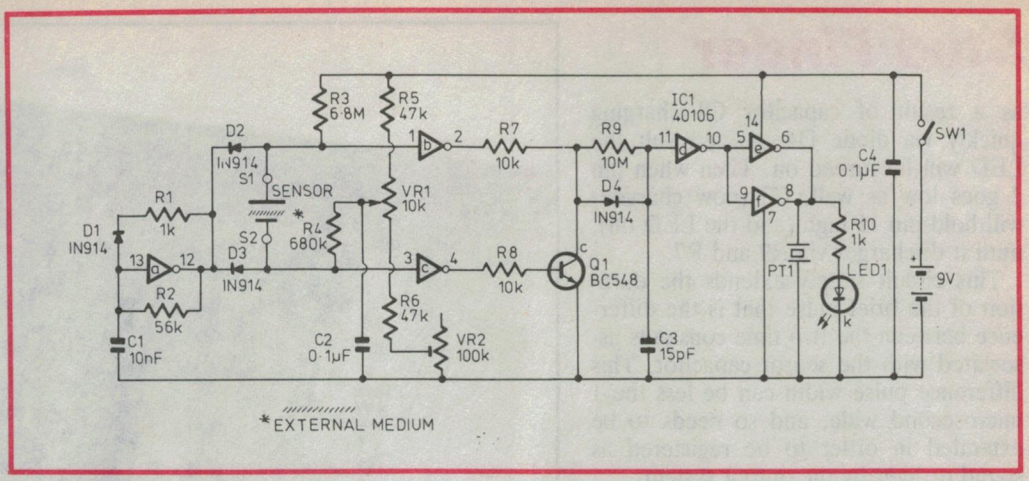
The unit is easy to use, very sensitive and fully adjustable to suit varying materials.

Incidentally this project has been designed by the R&D Department of Dick Smith Electronics, and copyright to the PC board pattern and front panel artwork is held by that company. This means that they cannot be reproduced commercially. However complete kits for the project will be available from all Dick Smith Electronics stores, and many dealers. The kit is designated with the catalog number K-2723.

How it works

The sensing system of the Stud Finder is designed to detect changes in the dielectric constant of materials under the sensing head. A sensitivity control allows setting of the detection threshold point for varying materials.

The circuit uses CMOS Schmitt trigger inverters as the active components.



The circuit for our Stud Finder is deceptively simple. Explaining exactly how it works isn't nearly so easy...

Six inverters are used in all, provided by a single 40106 hex inverter device. This makes for low cost and a simple layout.

The principle of operation is based around the detection of changes in the effective dielectric constant of the medium being scanned (the wall board), caused by the presence of a stud or noggin behind it.

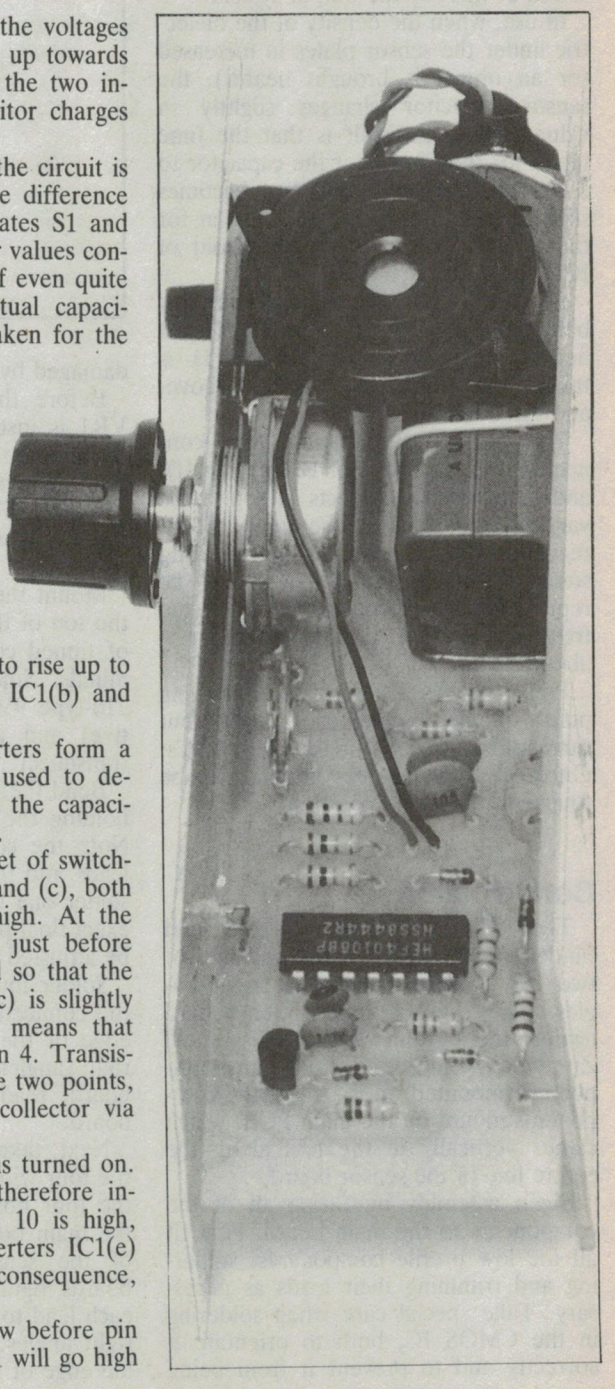
The sensor is actually a two-plate capacitor, with the external wall material as its dielectric or coupling material. The two plates S1 and S2 are actually copper areas of a small PCB, mounted hard up against the bottom of the Stud Finder's case. They are deliberately made of different sizes, with S1 a fairly large solid rectangle and S2 a smaller-area open rectangle around it.

One of the 40106 Schmitt inverter elements IC1(a) is connected as an astable oscillator. This oscillates at about 3kHz, with a very short duty cycle caused by the ratio of R1 and R2. Resistor R1 essentially determines the "pin 12 low" part of the oscillator cycle, while R2 determines the "pin 12 high" part – both in conjunction with capacitor C1. The ratio of high to low times at pin 13 is therefore quite high, with the low time typically only around 6.5 microseconds.

The effect of diodes D2 and D3 is to discharge the S1/S2 sensor capacitor by connecting both plates to the circuit's negative rail, during the brief time that the output of IC1(a) goes low. Then when the output of the oscillator goes high again, D2 and D3 cease conducting. This allows the sensor capacitor to begin charging, via R3 on the S1 side (connected directly to the positive rail) and R4 on the other (connected to an adjustable voltage from VR1, the sensitivity control).

Large plate S1 is connected to pin 1 of inverter IC1(b), while small plate S2 connects to pin 3 of inverter IC1(c). So when D2 and D3 turn off, the voltages at pins 1 and 3 begin rising up towards the switching thresholds of the two inverters, as the S1/S2 capacitor charges up via R3 and R4.

Operation of this part of the circuit is quite subtle. Because of the difference in size between the two plates S1 and S2, and the different resistor values connected to each, the effect of even quite small changes in their mutual capacitance is to vary the time taken for the voltages at pin 1 and pin 3 to rise up to the switching thresholds of IC1(b) and (c), in a differential fashion.



A look inside the case. Apart from the sensor itself, on the lower PCB, there's only a single IC with one transistor and a handful of parts.

In effect these two inverters form a very sensitive comparator, used to detect very slight changes in the capacitance of the S1/S2 capacitor.

Normally, before the onset of switching or triggering of IC1(b) and (c), both pin 2 and pin 4 will be high. At the point of sensitivity setting just before maximum, VR1 is adjusted so that the triggering of inverter IC1(c) is slightly *after* that of IC1(b). This means that pin 2 will go low before pin 4. Transistor Q1 is connected to these two points, the base via R8 and the collector via R7.

When pin 4 is high, Q1 is turned on. Its collector is near 0V, therefore inverter IC1(d)'s output pin 10 is high, forcing the outputs of inverters IC1(e) and (f) to go low. As a consequence, the LED will be off.

Now, should pin 4 go low before pin 2, Q1 will be off, so pin 11 will go high

as a result of capacitor C3 charging quickly via diode D4. As a result the LED will be turned on. Then when pin 2 goes low as well, C3 (now charged) will hold pin 11 high (and the LED on), until it discharges via R9 and R7.

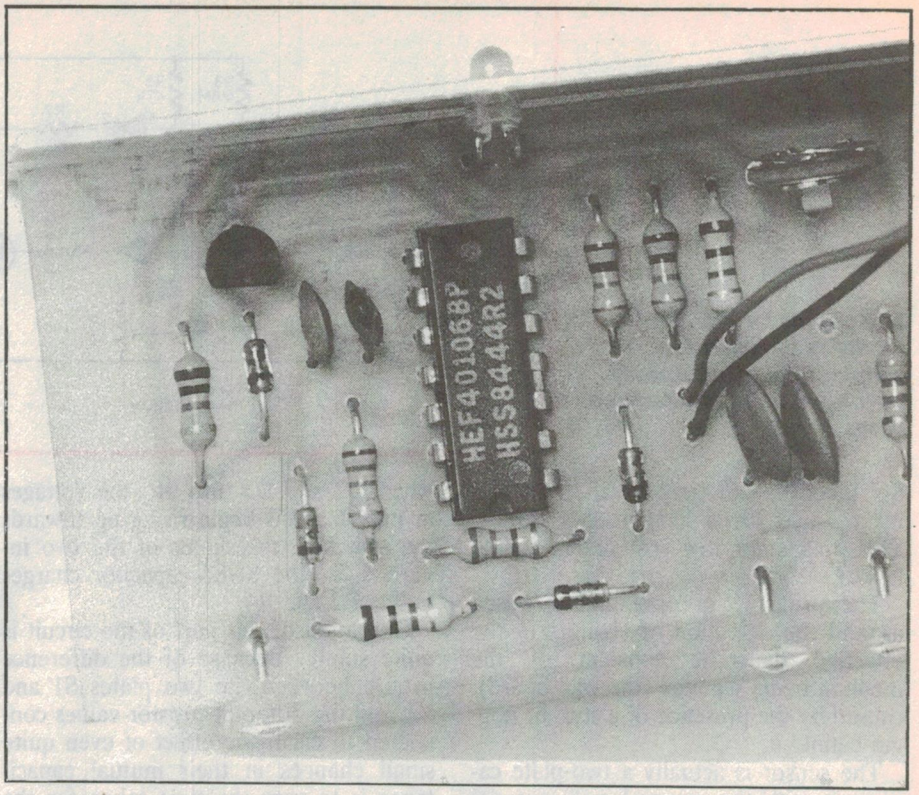
This circuit simply extends the duration of the brief pulse that is the difference between the two time constants associated with the sensor capacitor. This difference pulse width can be less the 1 microsecond wide, and so needs to be extended in order to be registered as sound or light by the output system.

In use, when the density of the dielectric under the sensor plates in increased (or an object is brought nearer), the sensor capacitor changes slightly in value. The nett result is that the time taken for the S2 side of the capacitor to reach the threshold of IC1(c) becomes slightly shorter than the time taken for the S1 side to reach the threshold of IC1(b).

Because of this pin 4 goes goes low before pin 2, and Q1 is turned off just before pin 2 goes low. So pin 11 is taken high briefly, as described above, and the LED turns on.

The piezo transducer is also connected to the outputs of IC1(e) and (f), and as a result it reflects in sound the varying conditions of the input. Slight reactions will be heard as short ticking sounds, while larger changes will be represented by a constant tone at the frequency of the astable oscillator – about 3kHz.

Preset pot VR2 adjusts the operating point of the circuit for the different threshold levels of different 40106 ICs. Once set, this pot does not have to be touched in normal operation.



Construction

The componments used in the Stud Finder are mounted on an assembly of two PC boards, mounted at right angles. The sensor board mounts hard against the bottom of the unit's small Zippy box, and does not have any components mounted on it. All of the components mount on the main PCB, which stands vertically in the box along the centre line of the sensor board.

Begin assembly by fitting all of the components to the main board. First fit all the low profile components, soldering and trimming their leads as necessary. Take special care when soldering in the CMOS IC, both to orientate it correctly and to prevent it from being damaged by static electricity.

Before the PC board mounting pot VR1 is installed, it is advisable to cut the shaft to length to fit the knob being used. We cut the prototype 18mm from the body. Fit the pot to the board with the pin shoulders right up to the board surface.

Mount the on-off slider switch flat on the top of the board using three lengths of tinned copper wire through the terminals. Solder in the leads from the 216-type 9V battery snap (red to positive) and also those from the piezo transducer.

Bend the LED pins close to the body, holding the legs with long nose pliers. Note the correct orientation. Push the leads into the PCB holes, but only tack solder one leg at this stage because the exact final position of the LED needs to be adjusted later.

Solder four lengths of copper wire to the connection points along the bottom edge of the main PCB. Bend these at right angles to point away from the board, ready to mate with the sensor board.

Next, take the sensor board and align the four wires from the main board with the four holes down the middle - with the main board on the non-copper side of the sensor board. Push the two boards tightly together and bend over each lead to hold the two in position, at right angles. Then cut off each lead at the edge of the pad and flatten the wire against the board. Solder each lead, making sure each joint is as low in profile as possible on the copper side. This is to avoid problems when the assembly is mounted in the box (the sensor board needs to be able to mount hard against the bottom of the Zippy box, for maximum sensitivity).

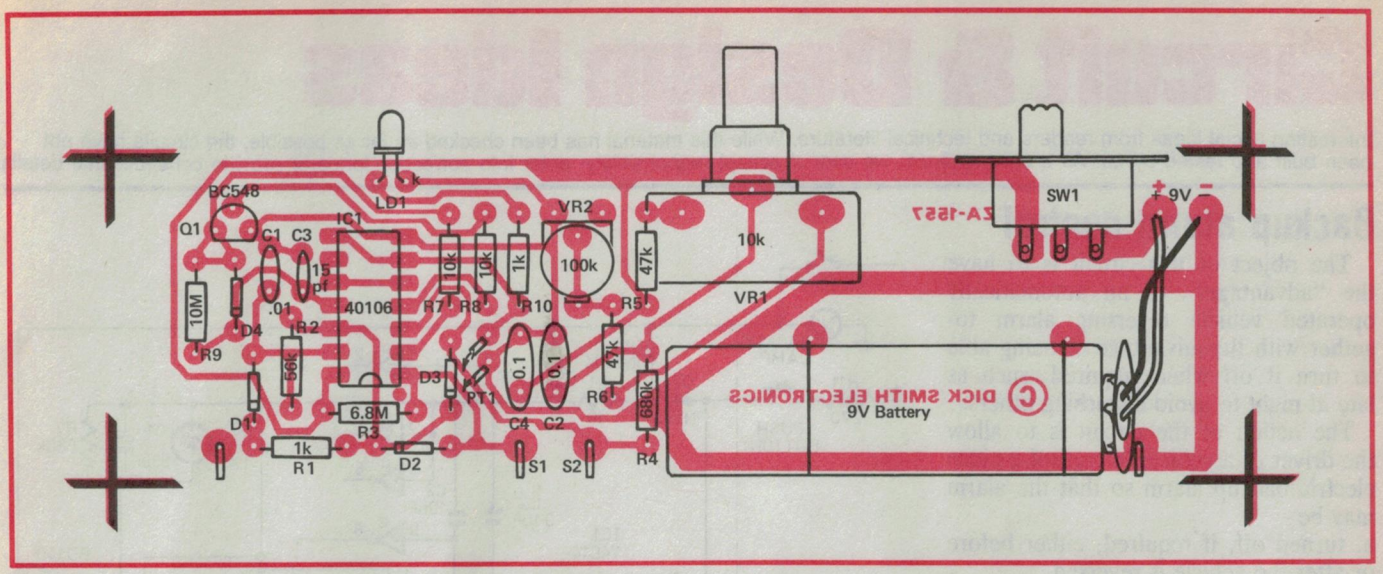
To hold the battery in a stable position, mount it as shown and support with wire straps between the main and sensor board.

The completed assembly should slip into the Zippy box with ease. The edge of the main board should be just below the surface of the box edges, to allow you room to fit the aluminium panel. If it is too high, you may have to reduce the profile of the solder joints on the bottom of the sensor board.

The aluminium front panel has to be drilled to suit the components penetrating its surface. The diagram shows the detail of these cutouts. You can use the label as a template to mark these positions. The pot and LED holes can be carefully drilled, but the switch hole has to be pilot drilled and then filed to the required rectangular shape with a needle file (or cut with a piercing saw).

No holes have been indicated for the switch mount screws. We found they were not necessary in the prototype, but you can add these if you like.

Try the panel for fit before the next step. If necessary, adjust the position of the LED for the best fit with the hole in



Construction should be easy using this overlay diagram and the picture opposite as a guide.

the front panel. When this is right, solder and trim the leads.

After each hole in the front panel has been dressed and freed from burrs, the self-adhesive label can be applied. Make sure it is correctly aligned before pressing it down on the surface. Then punch or cut out the holes carefully. Use a small scalpel blade or similar to cut to the edge of the switch opening. The drills used for the pot and LED holes can be used to punch through the label from front to rear.

The piezo transducer fits neatly between the battery and the box wall, adjacent to the pot. The front panel holds it in place.

Setting up

Power up the unit. The LED and transducer may or may not operate at this stage, depending on the position of presets VR1 and VR2.

To set the correct operating point, set sensitivity control VR1 to the mid position and put the PCB assembly in the Zippy box. Make sure the sensor PCB is hard against the bottom of the box. Place the box flat on some wooden surface, and adjust VR2 with a screwdriver until the LED just starts to light. Now fit the box front panel (without screws), along with the knob.

Try the unit on different materials: wood, plaster, plastic, glass etc. The sensitivity control should adjust for varying materials within a third of its full travel, centred around the mid position. Note that these adjustments are made with your fingers around the sides of the box, near the bottom (on-off switch) end. You will notice a slight variation in sensitivity setting as you touch the knob.

After adjustment is complete, the lid can be screwed in position. If you wish to put a nut on the pot, two to three washers may be needed to pack the pot body from the panel. Fit the knob and your Stud Finder is ready to use.

Using it

Place the Stud Finder flat on the surface to be scanned, holding it with one hand at the bottom end of the box. Adjust the sensitivity control until the transducer just starts to tick, then take your hand from the knob. The ticking should stop. You may need to re-adjust to get the most sensitive setting.

Now run the finder over the wall to get an idea of its operation. The LED at the cross centres indicate the centre of the sensor. Try the unit with known conditions, thickness of panels, types of materials etc.

The Stud Finder is capable of working with a great variety of materials and is sensitive enough to penetrate thick panels.

Remember, it basically detects changes in dielectric. Don't expect it to detect metal through metal – although it is perfectly happy to detect metal studs, pipes or conduits through insulating panels.

With a little operating experience, you can also use it to detect electrical wiring close to the surface. The field around the wires modulates the sound from the transducer.

The Stud Finder will even indicate the direction of grain in a piece of wood when the sensitivity control is set carefully. Even a knot or dense part in the grain structure can be found.

You may well be able to think of other applications for the Stud Finder, taking advantage of its principle of operation. It could conceivably by used to sense the presence of fluid in a plastic pipe, as a proximity detector, to check for the presence of moisture, or perhaps even as a pH meter. EA

PARTS LIST

1 Main PCB, 124 x 36mm, code ZA-1557
1 Sensor PCB, 105 x 59mm, code ZA-1558
1 Zippy box, 132 x 69 x 42mm
1 216-type 9V battery with snap lead
1 Piezo transducer
1 Mini DPDT slider switch

Semiconductors

1 40106 CMOS hex Schmitt inverter
1 BC548 or similar NPN transistor
4 1N914, 1N4148 or similar diode
1 3mm red LED

Resistors

1/4W carbon: 2 x 1k, 2 x 10k, 2 x 47k, 1 x 56k, 1 x 680k, 1 x 6.8M, 1 x 10M
1 10k linear PCB mount pot
1 100k linear vertical or horizontal PCB mount trimpot

Capacitors

1 15pF ceramic
1 10nF ceramic
2 0.1uF ceramic

Miscellaneous

Tinned copper wire, knob for pot, insulated hookup wire for mounting battery, etc.

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

Backup alarm control

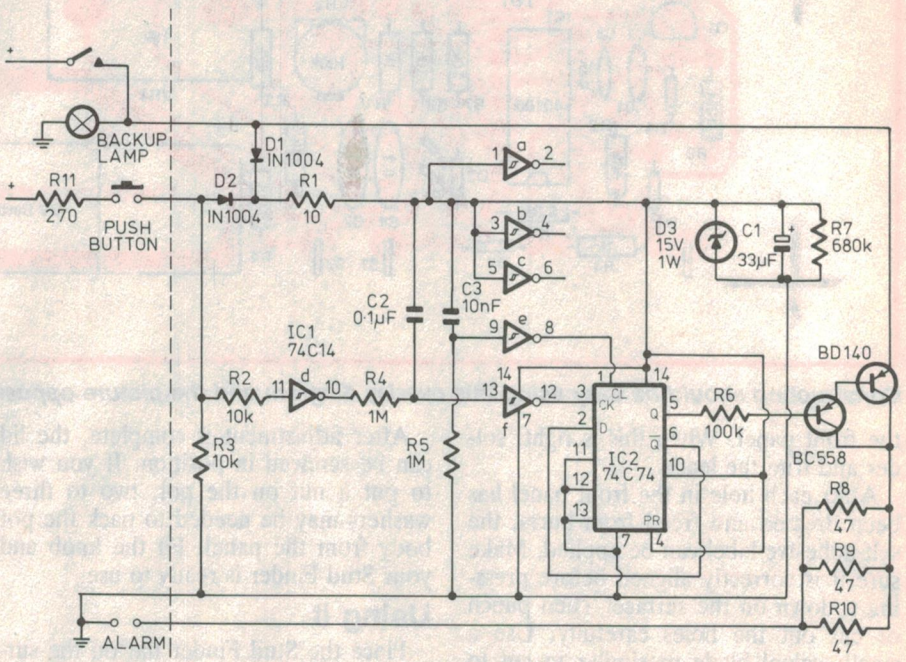
The object of this circuit is to have the "advantages" of an automatically operated vehicle reversing alarm together with the advantage of being able to turn it off when required, such as late at night to avoid disturbing others.

The action of the circuit is to allow the driver of a vehicle to control a piezo electric backup alarm so that the alarm may be

a. turned off, if required, either before or after the vehicle is reversed

b. maintained in the "off" condition, if set, for approximately 30 seconds after the vehicle is taken out of reverse

c. turned on again, if required, while the vehicle is being reversed.



Thus, if no action is taken before placing the vehicle into reverse, the alarm will sound. This may be silenced by operating the push button, either after placing the vehicle into reverse or up to 30 seconds before this. The alarm will then not sound while manoeuvring the vehicle in the forward and reverse directions, as when parking, but will sound if the vehicle is placed into reverse after having been left parked or driven forward for more than 30 seconds.

When power is applied via the lead to the back-up lamp, C1 charges to the 12 volt supply voltage via D1 and R1 and this, via C3 to the input of IC1e (Pin 9), causes an earth potential (logical 0) to appear at the output of IC1e (Pin 8). This is applied to Pin 1 of IC1a, which is the clear input of a dual D flip-flop. This pulse lasts for about 10ms, until C3 charges through R5. Hence, the Q output of the flip-flop is set at earth potential (logical 0) and Q1 and Q2 conduct, turning on the alarm via R8, R9 and R10 in parallel. The Q-bar output of IC2a (pin 6) is set to logical 1.

The earth potential via R3 and R2 holds the input of IC1d (pin 11) low, causing its output (pin 10) to be high. This holds the input of IC1f (pin 13) high, thus maintaining its output (pin 12) and the Clock input of IC2 (pin 3) low.

If the push button is now operated, almost the full 12 Volt potential is applied via R11 and R2 to the input of IC1d and, after a 100ms delay caused by the charging of C2 via R4, the output of IC1f and the Clock input of IC2a go high. This causes the data at D, which is connected to Q-bar, to be transferred to the Q output of IC2a, turning off Q1 and Q2 and thus stopping the alarm.

If the push button is subsequently operated and released, the flip-flop will toggle each time it is operated; turning the alarm ON or OFF as required.

Because of the low current drain of the CMOS components, the discharge time of C1 is almost entirely dependent on the current through R7. Thus, if the circuit is set so that Q1 and Q2 are not conducting, this will be "remembered" until C1 is below two thirds of the supply voltage, which takes about 30 seconds. Therefore, once the circuit is set to "OFF", the vehicle can be manoevured backwards and forwards without the alarm sounding, so long as any period of forward motion does not exceed 30 seconds.

In addition, if the push button is operated immediately before selecting reverse, C1 will charge via D2 and R1 and the Q output of the flip-flop will be set low by a 10ms pulse via IC1e as before. However, after a further 90ms, a clock pulse will be received via IC1d and IC1f causing the flip-flop to toggle and thus disabling the alarm.

R8, R9, R10 and R11 are not essential to the operation of the circuit. However, R11 prevents a "raw" 12 volt supply being available on the contacts of the dashboard mounted push button switch, and the alarm unit used was found to be somewhat erratic in its period and frequency of operation without a small amount of resistance in series with its supply.

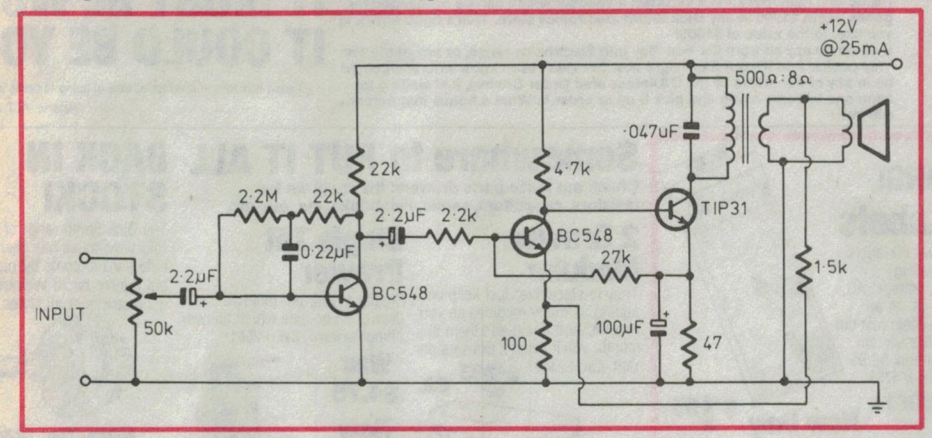
The unused inputs of IC1 (a,b, and c) and IC2 (b) are tied to the 12 Volt or Earth levels as appropriate.

P.B. Taylor,
Box Hill North, Vic. **$50**

Dreamed up a great idea?

If YOU have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish — not a fortune, perhaps, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address, or course!). Send them to Jim Rowe, Electronics Australia, PO Box 227, Waterloo 2017.

Simple 3-transistor amplifier



This thre transistor amplifier uses a single ended class A output stage which eliminates crossover distortion and does not need any bias adjustments to set it up. The output transformer is sold by Jaycar. Output power is about 80mW. Of course, the speaker should be as large as possible and well baffled to get maximum efficiency.

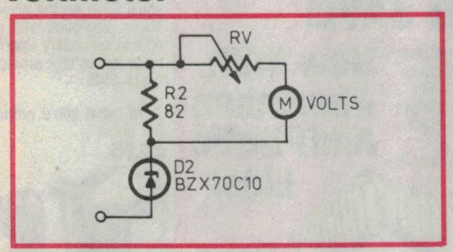
Gain is such that a low impedance dynamic microphone as used with tape recorders can drive the amplifier to full output. It would also work well with the regenerative and reflex radios recently described in EA.

Negative feedback is used, which is rare on simple amplifiers, to improve sound quality. Current consumption is about 25mA at 12V.

John Hunter,
Northbridge, NSW

$30

Suppressed zero voltmeter



This simple circuit makes an expanded scale type voltmeter from any ordinary meter.

Values and type of parts in the diagram are for 12V car battery monitor. There are three points marked on the scale of the voltmeter: 10.8V for a flat battery, 13.8V for a fully charged battery and 14.4V for correct charging voltage. The fields between these points can be colour distinguished. Voltages outside this range indicate faults, either with the battery or regulator.

Basic rules for design of this voltmeter are: Zener diode determines minimum (zero) voltage. For resistor Rz use the equation

$Rz = (Vv-Vz)/Iz$

where Vv is average input voltage, Vz is zener voltage of diode and Iz is the diode current.

Rv is best set up by trial, otherwise you need to know sensitivity of your voltmeter. This resistor determines the maximum voltage on your scale.

Michal Cedrych,
Lenah Valley, Tas.

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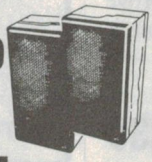

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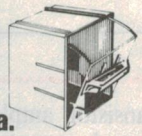
Similar to left, but this has one drawer on an axle which allows tilting forward. Cat H-2581

Was $4.75
Now $3.95 ea.



And The Big Guns (With Big Savings!):

A big 290×220×45mm case with internal divider containing multiple sections. Cat H-2596

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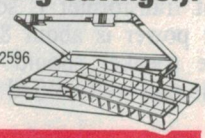

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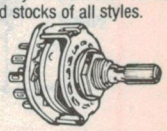

Positions	Poles	Cat No
2	6	S-6302
3	4	S-6303
4	3	S-6304
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12	1	S-6312

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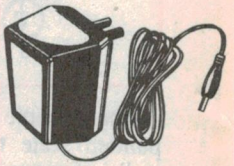

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4.7uH	L-1767	330uH	L-1807
6.0uH	L-1769	470uH	L-1811
8.2uH	L-1771	560uH	L-1813
10uH	L-1773	820uH	L-1817
15uH	L-1775	1mH	L-1820
22uH	L-1779	1.5mH	L-1822
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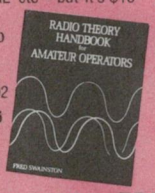

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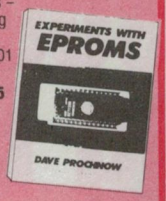

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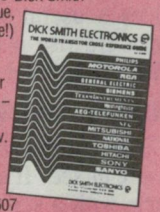

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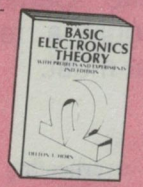

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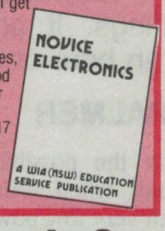

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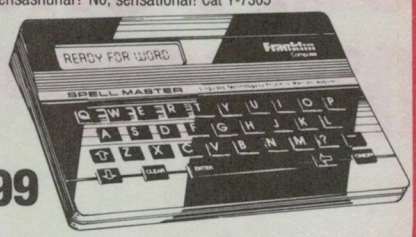

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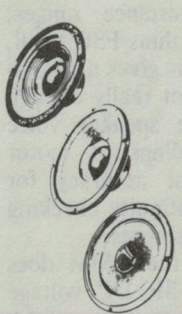

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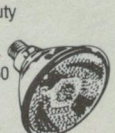

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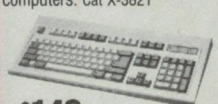

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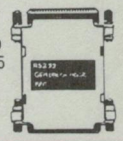
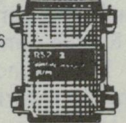
"D". Male to Male X-3565



Female to Female X-3566



Each: **$12.95**

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We have a huge range of ready-made computer cables or the cable, and plugs & sockets to make up your own. Here are just two examples:

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DICK SMITH ELECTRONICS

B624B

Construction project:

Current source for measuring low R's

Here's a handy little gadget which can be used to adapt your digital voltmeter for measuring low resistances like speaker voice coils and transformer windings. It costs only a few dollars and can be put together in an hour or two at most.

by ANDREW PALMER

The little current source unit to be described is very simple indeed. Like many such devices it was basically put together to fill a personal need.

My DMM is fairly typical, I suspect. It doesn't have 2-ohm or 20-ohm FSR (full-scale reading) resistance ranges; the lowest range is 200 ohms FSR (well, 199 ohms, actually). This gives a resolution of only 1 ohm – not really enough to measure things like speaker voice coils, transformer windings or motor windings with sufficient accuracy for anything more than continuity checking and "ball park" measurements.

On the other hand, the DMM does have 200mV and 2V FSR DC voltage ranges, and these are sensitive enough to measure quite low resistances, provided that you arrange to have a known current of say 100mA flowing through them. This gives effective current ranges of 2 ohms and 20 ohms respectively, with resolutions of .01 ohms and 0.1 ohms – much more useful.

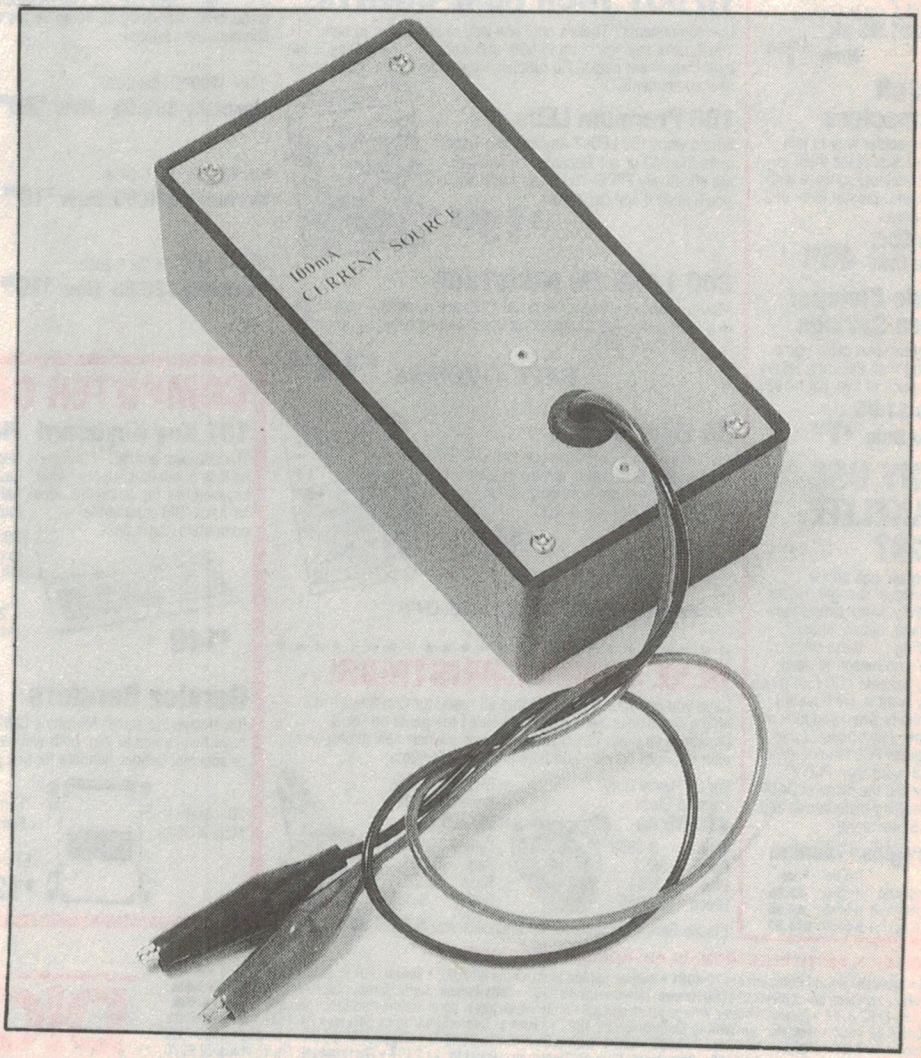
So that's the idea behind this little external current source: to provide a known and accurate constant current of 100mA, to let you measure low resistances using your DMM's low voltage ranges.

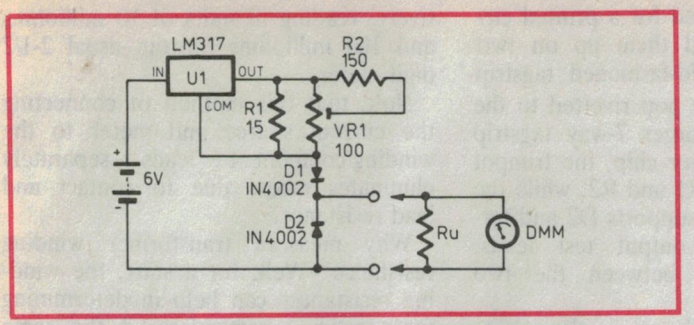
Note that a current of 100mA should not be sufficient to cause any damage to most low resistance windings, particularly if it's only applied for the duration of your measurements. Most windings in transformers and motors work at rather higher current levels anyway, while things like speaker voice coils are generally wound from solid enough wire to take this current for a short time without any problems. Still, you should bear the possibility of overheating in mind, when using the current source with very low power items.

Incidentally, the ability to measure the resistance of a transformer winding or motor winding accurately also provides a useful way to measure its temperature rise in operation. But more of this a little later.

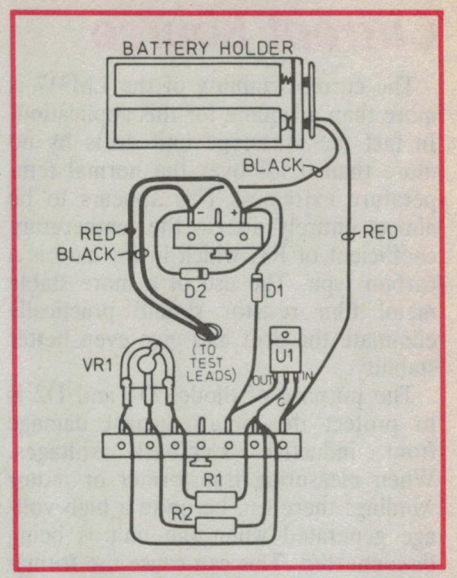
How it works

The circuit is extremely simple, as you can see. It's basically just a 6V battery, with a series LM317 three-terminal voltage regulator device connected as a current regulator.





Left: The circuit is very simple – just a 6V battery and an LM317 connected as a current regulator. Diodes D1 and D2 protect against inductive "kick back".



Above: Wiring up the unit should be easy using this pictorial diagram as a guide.

How can a voltage regulator chip be used to regulate current? Basically by connecting an appropriate resistance between its output and common pins, and arranging for the chip to develop (or attempt to develop) a known voltage across this resistance.

In this case the resistance connected across the output of the chip is very close to 12.5 ohms, formed mainly by R1 but with R2 and VR1 shunted across it to bring the value down to the final figure. The purpose of VR1 is to allow fine adjustment, in the range 12 - 13 ohms.

The output voltage of the LM317 in this configuration will tend to be that of its internal reference, which is nominally 1.25V but rated to be within the range 1.2 - 1.3V. So that by using VR1, it becomes possible to set the LM317's current level accurately to (1.25/12.5) amps, or 100mA.

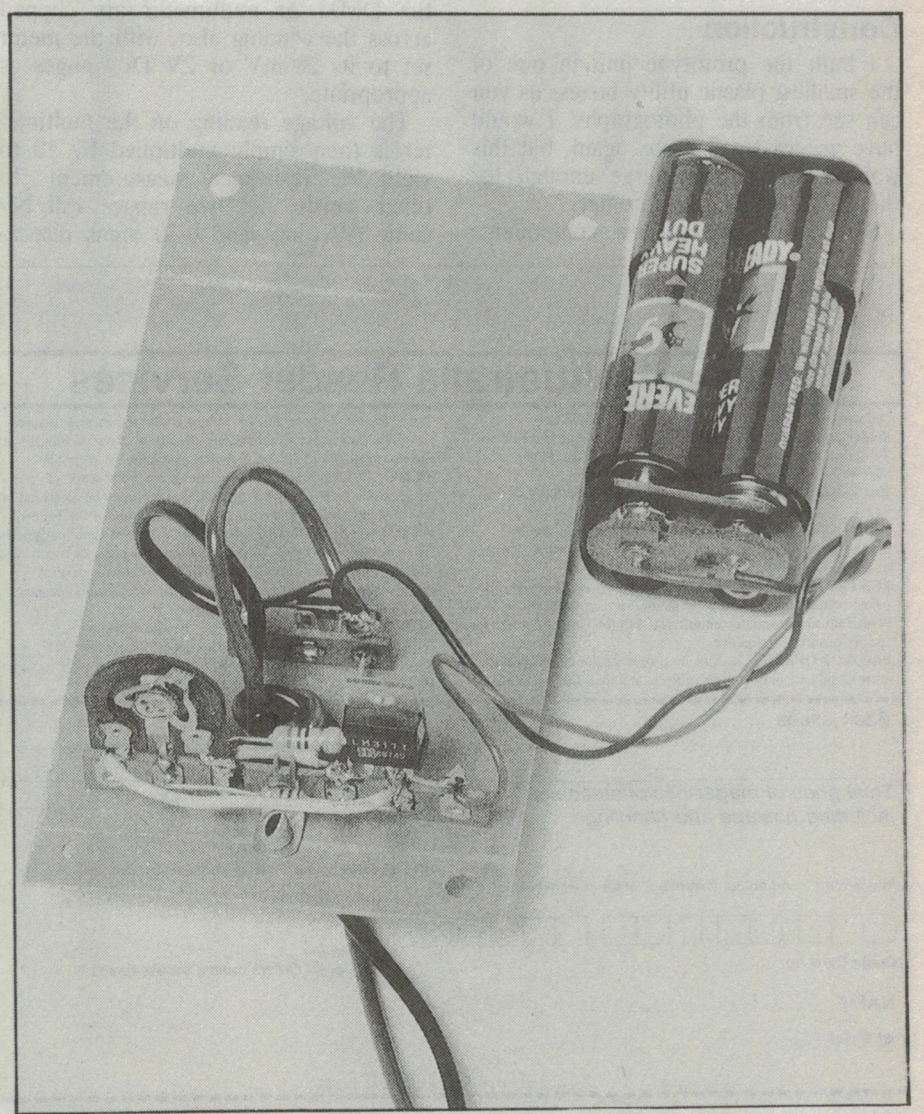
Of course this is when a low value load resistor Ru is connected to the circuit; until such a load is connected, no current flows at all. And of course for the LM317 to maintain this 100mA current level accurately, the value of Ru must be low enough to ensure that its voltage drop at this current level is low compared with the 6V battery. Otherwise, the voltage available to the LM317 itself will fall below its "drop-out" level.

With the present circuit, load resistors of just over 20 ohms can be connected before the LM317 "runs out of voltage" and cannot maintain regulation of the 100mA current level. So everything works out rather well.

Why only a little over 20 ohms – surely this would drop only 2V at 100mA? Don't forget that there's also the drop across R1, R2 and RV1, which will drop another 1.25V, and diode D1 which accounts for another 0.65V. So for a 20-ohm external load resistor the voltage available for the LM317 will be (6V - 3.25V - 0.65V), or 2.1V. This is only a little above the device's drop-out level.

Of course this assumes that the battery voltage will remain at 6V with a drain of 100mA, which is a little optimistic. In practice the circuit will only cope with loads a little over 20 ohms before the current level starts to fall.

Needless to say the output current level must be set as closely as possible to 100mA for accurate resistance measurements. This can be done using the DMM itself. Most DMMs have a current range capable of measuring 100mA quite accurately.



How the author built up his current source, with the parts supported by two small tagstrips rivetted to the front panel.

Current Source

The current stability of the LM317 is more than adequate for this application. In fact the prototype unit drifts by no more than 0.5% over the normal temperature extremes. This appears to be almost entirely due to the temperature coefficient of R1, which in my case is a carbon type. The use of a more stable metal film resistor should practically eliminate the drift and give even better stability.

The purpose of diodes D1 and D2 is to protect the circuit against damage from inductive kick-back voltages. When measuring transformer or motor windings there can be quite a high voltage generated when the unit is being disconnected. This can cause the formation of an arc, in some cases. With D1 and D2 the risk of circuit damage is minimised.

Construction

I built the prototype unit in one of the smallest plastic utility boxes, as you can see from the photographs. I would have used a smaller box again, but this wouldn't have been large enough for the 4 x AA-cell battery holder.

Since there are so few components used, there's no need for a printed circuit board. I wired them up on two small lengths of old-fashioned tagstrip (gasp!), which were pop rivetted to the front panel. The larger 7-way tagstrip supports the regulator chip, the trimpot RV1 and resistors R1 and R2, while the smaller 3-way strip supports D2 and terminates the two output test leads. Diode D1 swings between the two strips.

The details are shown in the wiring diagram and inside photo, for those that want to duplicate the original. But the circuit is not at all critical, and you could build it in almost any form you wish.

Using it

In use, the leads from the unit are simply clipped across the winding or other low-resistance component you wish to measure. Then the leads from the DMM or multimeter are clipped across the winding also, with the meter set to its 200mV or 2V DC ranges as appropriate.

The voltage reading on the multimeter is then simply multiplied by 10 to yield the resistance measurement. In other words, the two ranges will become 0-2 ohms and 0-20 ohms respectively, reading in units of 10 milliohms and 100 milliohms for the usual 2-1/2 digit meter.

Note that this method of connecting the current source and meter to the winding/component leads separately eliminates errors due to contact and lead resistance.

Why measure transformer winding resistance? Well, for a start, the winding resistances can help in determining turns ratio – particularly if the same gauge of wire is used.

It's also a very easy and practical way to measure temperature rise, when the transformer is operating. In this way you can assess whether the transformer is operating within the temperature ratings for its insulating materials.

If the resistance of the windings is measured when the transformer is "cold" (i.e., at ambient temperature), and then measured again after the transformer has been operating at full load for a few hours, the winding temperature can be calculated from the expression:

$$T2 = (Rb/Ra).(235 + T1) - 235$$

where T1 is the "cold" temperature (^{0}C), T2 is the "hot" temperature, and Ra and Rb are the "cold" and "hot" resistance readings respectively.

Note that this expression only applies for copper windings, however.

Normally, if the temperature of the winding has risen by more than about 75^{o}C, you might start to question whether the transformer concerned is adequate for the job. But don't forget that many modern transformers incorporate insulating materials able to withstand considerable higher temperatures.

I hope you find this little measurement aid as useful as I have done. EA

PARTS LIST

1	Utility case, 132 x 68 x 42mm
1	4 x AA-cell battery holder
1	battery snap lead to suit
4	AA cells
1	LM317 three-terminal regulator
1	100 ohm vertical trimpot
1	15 ohm 1/2W resistor (preferably metal film)
1	150 ohm 1/4W resistor
2	1N4002 or similar silicon power diode
1	7-way tagstrip
1	3-way tagstrip
2	Test leads with insulated clips
1	Rubber grommet, 8mm

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1. Local Post $2.50
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3. Carrier: Melbourne & Metropolitan — $5 up to 3kg
4. Carrier: Intrastate — $8 up to 3kg

only SMALL ITEMS will be sent by post.

Don't forget the Electronics Australia –

GRAND AUSSIE HOBBY

How good are YOU at designing a really novel and exciting hobby electronics project? Now's your chance to prove what you can do –

The Grand Aussie Hobby Electronics Contest is sponsored by *Electronics Australia*, the country's leading electronics magazine, and leading electronics retailer Dick Smith Electronics. The contest is open to all Australian electronics hobbyists, although entries must be accompanied by the entry form below (or a photocopy if you don't want to cut the magazine).

The idea of the contest is to encourage more Australians to take up electronics as an exciting and rewarding hobby. We're doing this by asking you to design the most novel, exciting, useful and easy to build project you can dream up – provided that the total current retail cost of the parts required to build it is less than $100.

It can be an electronic game, a test instrument, a radio set, a piece of amateur radio gear, an amplifier, an audio accessory, a useful gadget for use around the home or office or whatever, as long as it meets the above requirements. Now that shouldn't be too hard, should it?

Needless to say, you'll be expected to build up a neat prototype of the project, to make sure that it works properly. And to produce the usual things needed in a good project design to make sure that others can build it up easily: things like a printed circuit board pattern, and so on.

Each project entered in the competition should also be accompanied by a description of what it is, how it works and how to build it and get it going. In short, the manuscript of an article which could be used to describe it in *Electronics Australia* – complete with neatly drawn circuit and any other diagrams as necessary.

Not surprisingly we'll be awarding points not just for your project design itself, but for the way you've built up the prototype and your description of it as well. In short, for your overall presentation.

Along with the main prizes, there are two runner-up prizes in each category as well. In each case these are Open Vouchers, to purchase components or other products of your choice to the value of $100, at Dick Smith Electronics.

Rome wasn't designed and built in a day, and neither are good electronics projects. That's why we're giving you three months to prepare your entry. The closing date is September 30, so entries sent to us but postmarked after that date won't be eligible for the competition. The winners will be advised by mail before the end of October, and will be announced in the December issue. If possible we'll also be presenting the winning projects in that issue, as well.

What encouragement is there for you to enter this exciting new competition? Well, for a start there are some great prizes. All up, the total value of prizes being offered is over $3500!

To be fair to both newcomers and more experienced hobbyists, we've decided to award not one but TWO main prizes – one for people in each category. The two prizes are of roughly equal value (both more than $1500), but structured to suit people at different stages of hobby involvement. In each case they provide a mouth-watering collection of the things you've probably always wanted, but couldn't really afford. At the same time they'll provide a tremendous boost to your home workshop, and help you move on to even bigger and better things – what could be more appropriate for a contest designed to encourage hobbyists!

Along with the main prizes, there are two runner-up prizes in each category as well. In each case these are Open Vouchers, to purchase components or other products of your choice to the value of $100, at Dick Smith Electronics.

In addition to these prizes from Dick Smith Electronics, the winning and runner-up project entries are likely to be published in *Electronics Australia* – the largest selling and most respected electronics magazine in Australasia. How's that for being seen by the largest number of your fellow hobbyists – and having them build YOUR design! When your design is published, you will of course receive the usual contribution

OFFICIAL ENTRY FORM:

Here's my entry to the contest. I affirm that this is an original design by me, and that I have built and tested a prototype unit to make sure that it works as claimed. The accompanying description is also all my own work. If my entry is judged one of the winners, I am happy to supply the prototype unit to EA and DSE for testing, photography and preparation of a kit.

NAME: ..... **PHONE NUMBER:** .....

ADDRESS: .....

..... **POSTCODE:** .....

CATEGORY OF ENTRY: (Tick which one) Newcomer ☐ **Advanced** ☐

OCCUPATION: .....

MAIN INTEREST IN ELECTRONICS AS A HOBBY: .....

ESTIMATED COST OF PARTS IN YOUR ENTRY: $ .....

I understand that a condition of entering this contest is that Electronics Australia magazine shall have first option on publishing details of my design/project, and that Dick Smith Electronics shall have first option on marketing any kits based on the design/project. I also agree to abide by the decision of the contest judging panel.

SIGNATURE:

.....

Dick Smith Electronics

ELECTRONICS CONTEST!

whether you're an enthusiastic newcomer, a seasoned old timer or anyone in between. There are great prizes to be won!

fee, as well.

Needless to say Dick Smith Electronics is also going to be interested in producing kits for the winning projects, to make it easy for other readers to build them up. So you'll receive not only fortune but fame as well – what more could you possibly want?

So don't delay – start working on your entry today. Whether you're a keen beginner or an experienced old-timer, you have an equal chance. Put on your thinking cap, and see if you can come up with a winning design!

A final point. To make it even easier for you to work on your entry, Dick Smith Electronics has decided to offer a special 10% discount on the components you may need to build up your prototype. So if you cut out the voucher on the bottom of this page and take it to your nearest DSE store, it will get you that very handy discount. How's that for being helpful!

Please note, however, that you must use the original voucher from the magazine – photocopies can't be used. The voucher can also be used only to purchase electronic components and associated hardware such as a case, knobs, connectors and PCB materials – not for other products. So write out a list of all the bits you'll need for your project entry, and make sure you get them all at once to take advantage of the 10% discount.

HERE ARE THE GREAT PRIZES TO BE WON:

NEW HOBBYISTS' SECTION

A. First prize:

Q-1280 6.5MHz Oscilloscope	$399.00
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T-2000 Solder Station	$129.00
Q-1220 RC Audio Oscillator	$119.00
Q-1335 Transistor Dip Meter	$129.00
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P-4616 Prototyping Breadboard	$ 39.95
PLUS — A DSE Components Voucher for	$400.00

A TOTAL PRIZE VALUE OF OVER $1500!

B. Two runner-up prizes of DSE Components Vouchers, each for the value of $100.00

ADVANCED HOBBYISTS' SECTION

A. First prize:

Q-1260 20MHz Dual Trace Oscilloscope	$899.00
Q-1666 Precision Digital Multimeter	$249.00
T-2050 Royel "Pro" Soldering Station	$199.00
PLUS — A DSE Components Voucher for	$250.00

A TOTAL PRIZE VALUE OF ALMOST $1600!

B. Two runner-up prizes of DSE Components Vouchers, each for the value of $100.00

TOTAL VALUE OF ALL CONTEST PRIZES OVER $3500!

(All prizes listed above are being donated by Dick Smith Electronics, and further details of each product can be found in the company's latest catalog.)

Prize winning entries and other selected entries may also be published in Electronics Australia, and all entries so published will of course earn an appropriate publication fee, in addition to any prizes awarded.

SPECIAL DISCOUNT VOUCHER: ▶

To make it especially easy for you to enter the Grand Aussie Hobby Electronics Contest, Dick Smith Electronics is offering this special discount voucher. By presenting the voucher at any Dick Smith Electronics store when you're buying the parts to build your project entry, you'll get a very welcome 10% discount!

(Discount only applies to components, etc., and voucher can only be used ONCE)

DICK SMITH ELECTRONICS

COMPONENTS DISCOUNT VOUCHER

I'm building a project for entry in the Electronics Australia – Dick Smith Electronics Grand Aussie Hobby Electronics Contest, and I hereby apply for my 10% discount on the parts I'm buying.

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CATEGORY (Tick): Newcomer ☐

Advanced ☐

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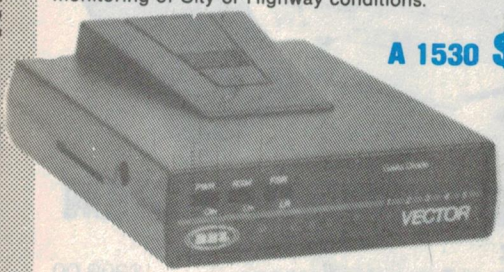

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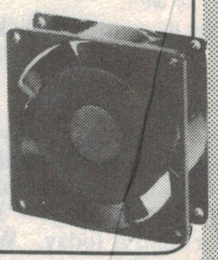

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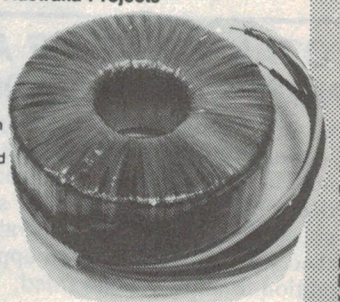

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M 3055	18 + 18
M 3060	25 + 25
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M 3070	35 + 35
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The Pin Point Ultrasonic Cleaner uses a transducer generator to produce millions of activated microscopic cleansing bubbles, which blow dirt, grease & grime off surfaces, and deep into cracks and holes.

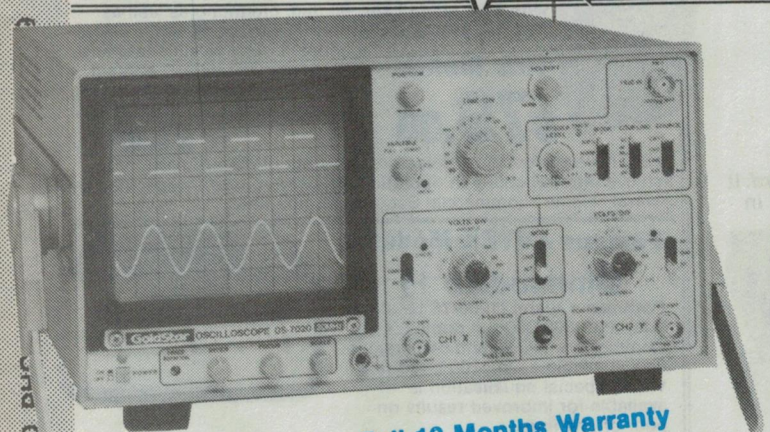
This personal ultrasonic cleaner won't scratch precious jewellery or glass. Comparison studies made by hospitals, commercial businesses and industry show ultrasonic cleaning proves better and safer than any conventional method.

But don't take our word for it. Test the Pin Point Ultrasonic cleaner yourself. Pop your dirty watches, glasses, connectors etc. into the cleaners stainless steel basin, add a cup of tap water, and three minutes later see the difference. The results are instantly revealing.

SPECIFICATIONS

Power Supply : 240V 50Hz **Power Consumption :** 300mA **Frequency :** 40 +/-2KHz **Dimensions :** 224 x 114 x 124mm **Capacity :** 570ml **Weight :** 1kg **Body Material:** ABS Plastic **Tank Material :** Stainless Steel (SUS 304) **On/Off :** 3 Minute Auto Timer.

★ **Amazing Price Breakthrough** ★



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This all new CRO must be the best valued quality Oscilloscope in Australia!

This new model is a 20MHz dual-trace Oscilloscope using a high brightness CRT with an illuminated scale. The vertical amplifiers have high sensitivity 1mV-5V/Div. The unit has LED's to indicate when the controls are in the 'uncal' postion, and to indicate if the trace has been triggered. The brilliant triggering circuit will trigger on just about any waveform applied. The highest triggering sweep is 0.2uSec/Div. The Q 0120 also features a 'Hold Off' control for seeing the front end of the input wave form.

Features: Large 6" rectangular CRT with internal graticule. • High sensitivity: 1mV/Div. • High accuracy: +or-3% • Stable, low-drift design • 8 divisions of displayed dynamic range and accurate distortion-free waveform measurements • This instrument has a special TV sync separation circuit for quick measurements of video signals • A convenient X-Y operation mode allows phase difference measurements between two waveforms.

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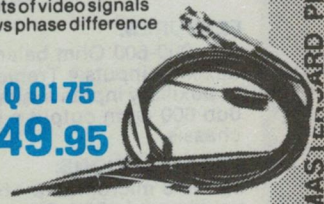

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Specifications: The pertinent specifications for the Model Q 1530 are listed as follows:-

1. **Measuring Mode - Frequency Measurements - Channel A** • Range: 10Hz to 10MHz direct counter 10MHz to 100MHz prescaled by 10 • Resolution: Direct counter: 1, 10, 100Hz switch selectable - Prescaled: 10, 100, 1000Hz switch selectable. • Gate time: 0.01S, 0.1S, 1S switch selectable • Accuracy: +/- 1 count +- time base error x frequency. **Channel B -** • Range: 100MHz to 1 GHz • Resolution: 100Hz, 1KHz, 10KHz switch selectale • Gate time: 0.027S, 0.27S, 2.7S switch selectable • Accuracy: +/- 1 count +/- time base error x frequency. **Period Measurements (Channel 4) -** • Range: 10Hz to 2.5MHz • Resolution: 10-7S, 10-S switch selectable • Accuracy: +/- 1 count +/- time base error x period. **Totalize measrements (Channel A)** • Range: 10Hz to 10HMz • Resolution: +/- 1 count of input. **General -** • Display: 8 digits, 7 mm red LED display with decimal point, gate, overlow, KHz, MHz and uS indication. • Check: Counts internal 10MHz time base oscillator • Power requirement: Line: 115/230V +/-15%, 45Hz-70Hz Internal Battery: Option • Temperature: Rated range of use: -5 deg. C - +50 deg. C — Storage and Transport: -40 deg. C - +60 deg. C • Humidity: Operating: 10-90% RH. Storage: 5 - 95% RH.

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Now your preamps, Amps, Control Modules Monitor Panels etc. can look every bit as good as Technics Nakamichi & other top manufacturers.

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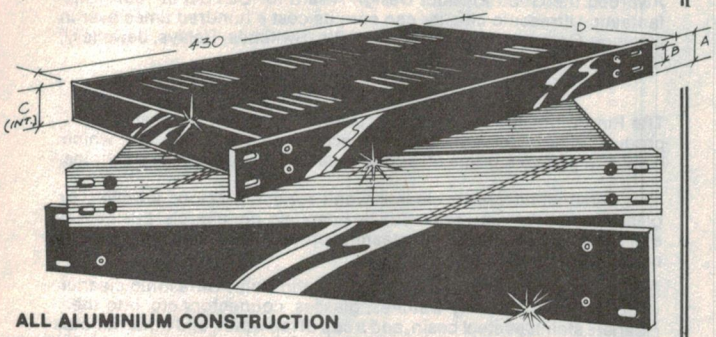

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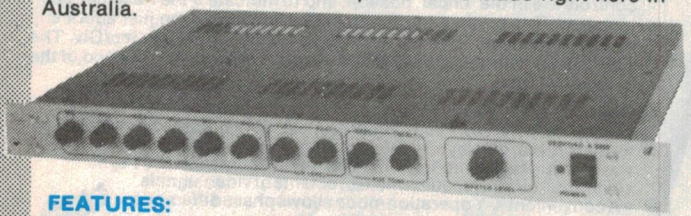
FEATURES: These beautifully crafted rack cabinet boxes will give your equipment a real Ist class appearance with removable top and bottom cover panels • All dimensioning conforms to the International Standard • Natural or Black finish • Ventilated lid • Deluxe finish front panel • Individually cartoned • Supplied in Flat Pack Form - Easily assembled in minutes - **Side Elevations:-** D=254mm C (Internal Chassis Height) • B (mounting Bolt Centres).

SIX NATURAL AND BLACK FINISH MODELS — The Black or Natural finish cabinets are each available in 44mm, 88mm or 132mm high models. Mounting hole centres conform exactly to International Racking Specifications both vertically and horizontally.

Cat. No.	Finish	A	B	C	Were	Now
H 0401	Natural	44	34	38	$59.95	$50
H 0402	Natural	88	57	82	$69.95	$62
H 0403	Natural	132	89	126	$85.00	$79
H 0411	Black	44	34	38	$59.95	$52
H 0412	Black	88	57	82	$79.95	$70
H 0413	Black	132	89	126	$89.95	$80

Quality *Redford* Industry Standard 8 Channel Mixer

This pro quality mixer is yet another fine product from *Redford*. It like most other *Redford* series products is made right here in Australia.



FEATURES:

• 6, 200-600 Ohm balanced microphone inputs • 2, 100K auxiliary inputs • Treble and bass on auxiliary inputs • Muting of auxiliary inputs available from microphone input • Balanced 0db 600 Ohm output • Housed in Stylish 1u 19" rack mount chassis.

SPECIFICATIONS:

Inputs 6 microphone - balanced - 200-600 Ohm. 2 Auxiliary unbalanced 100K Ohm. **Output** 600 Ohm balanced Odbm. **Sensitivity** Mic 1.25mV -Aux 100mV. **Frequency Res.**Mic 30Hz-15KHz, Aux (Flat) 18Hz-23KHz. **Tone Controls** Bass 100Hz +/-10db, treble 10KHz +/- 10db. **Signal to Noise** All controls CCW -95db **Distortion** at 1KHz less than 3%.

All measurements measured in respect to 1KHz reference

A 2050 $399

Sensational Super Buy On Quality Sampson 12V Rechargeable Batteries

This Quality 12V 1.2AH Lead Acid Battery Sells Elsewhere for $30!

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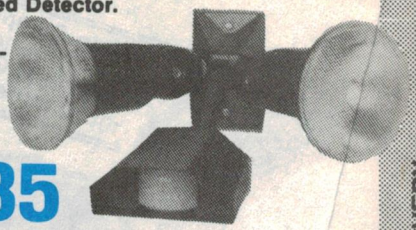
Passive Infra-Red Lite Guard Floodlight Control

How often have you thought there could be a prowler outside your door? Install a Lite Guard & (once armed) any "guest" will be floodlit when detected by this highly sensitive Infra-Red Detector.

Please Note Flood-lamps & Holders Not Supplied

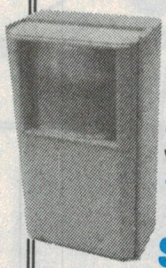


S 5350 $185

The lite Guard detects a moving person or vehicle by comparing the background temperature with a rapid change of temperature across the detection beams. So when Lite Guard detects movement across the coverage area, it will turn on the floodlight(s) for 1-20 minutes as pre-adjusted.

Specifications: Detector: Dual element pyroelectric PIR sensor • Raintight outdoor all weather operation. • Photocell to deactivate sensor during daylight • **Operating Voltage:** 240V AC, 50Hz • **Operation time:** Adjustable 1-20 minutes • **Sensitivity:** Adjustable 20'-50', 30 beams • Aimable desired direction with 2 ball joints • switching Capability: 500W max. incandescent. • **Operation Modes:** Off, Auto, Test, Manual Ont.

Passive Infra Red Movement Detector



New Model IRD Has Fantastic Range

Infra Red Movement Detector

With Two Mode Lens Why Pay $150 or More

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Features: Lens simply 'snaps' to either **wide angle** (range 40ft.) for normal use or **Normal angle** (range 80ft plus) for corridor applications. • Snazzy integral mounting brackets allows corner 90 deg. mounting as well as normal surface mount.• "Pulse count" circuit to eliminate false triggering.• "tamper" contact. • 12V DC Powered • Built-in test lamp • Alarm output SPDT 30V 1a.

S 5301

N.B. These professional detectors use state of the art circuitry to achieve ultra reliability in operation. They are currently specified by several "Name" commercial Security Companies.

Famous AVTEK Modems

Minimodem 11

Features: • Viatel (1200/75 baud rate) and 300/300 full duplex. • Commodore VIC 20 and 64 Versions now available • On 1200 baud (e.g. Viatel) special equalisation is available for improved results on poor phone lines.

Minimodem
Inc Power Supply

D 1225 ~~$199~~ $179

Minimodem
(suit Commodore user port)

D 1229 ~~$235~~ $212

Megamodem

These provide complete SM300 and SM2400 compatability, while also providing a simple to use menu driven mode where suitable software is not available.

• Automatic dial, answer and disconnect • All communications parameters, such as baud rate, parity and number of stop bits are set up automatically by the software and the Megamodem • Austpac compatible • Visual and audio feedback • 12 Months warranty.

Megamodem 12
300/300 1200/1200 V21/22

D 1230 ~~$375~~ $340

Megamodem 123
V21/22/23 (inc. automatic speed conversion for Viatel & videotext 1200/75 services)

D 1232 ~~$449~~ $408

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Jack O'Donnell
M/Director

Great Kit Projects To Build Many Just Released For 1988

Brilliant Performance Stereo Pre Amp

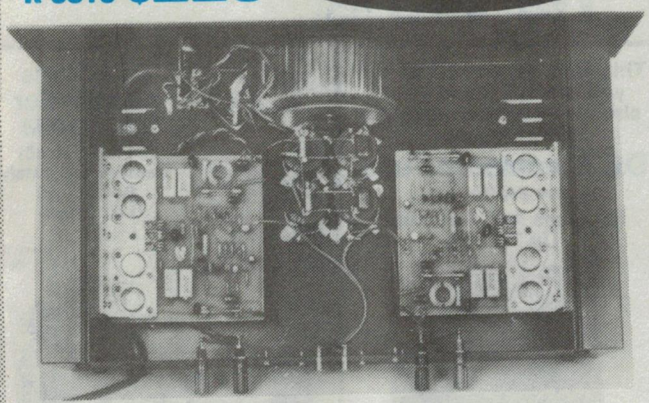
Studio 200 Stereo Control Unit
(Silicon Chip June/July'88)

Out-Performs Commercial Units Costing $600 Plus

The Studio 200 Stereo Control Unit is companion to the studio 200 stereo power amplifier (or other power amps). It features slim 1u rackmount profile, treble, bass, balance, input selector, tape monitor switch, stereo/mono switch and volume control. Inputs include phono, tuner, CD, VCR and tape loop.

K 5015 $229

Simple PCB Construction Virtually No Wiring



Calling All Audio Purists
This Great New Amp From Silicon Chip Is For You

K 5010

Studio 200 Series 100 Watts Per Channel Power Amplifier

$399

Features: • In-Built speaker protection • Toroidal Transformer (low hum) • Black Satin Finish • Low leakage power supply capacitors • Housed in Rugged Custom Chassis.

Specifications: • **Output Power** 100W into 8 Ohms **Freq. Res.(at 1W) 20Hz-50KHz** + or - 1db **Input Sensitivity** 870mV **Harmonic Distortion (20Hz-20KHz)** 0.1% **Signal To Noise Ratio** 100db or Better **Protection** 5A fuses plus RDE245A Polyswitch **Damping Factor** (without Polyswitches) 100 (with Polyswitches) 100. **Stability** Unconditional.

Discolite
(See Silicon Chip July/Aug'88)

Add Some Colour To Your Next Party

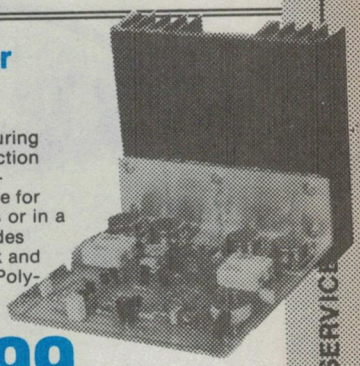
K 5805

$159.50

The Discolite Flashes party lights on and off in beat with music from your amplifier.
• 4 light channels controlled by 4 separate audio channels • Forward, reverse and auto-reversing chaser patterns • Simultaneous strobe on all four channels • Alternating light patterns • Music modulation available on chaser, strobe & alternate patterns • Inbuilt microphone for beat triggering or audio modulation of lights • Direct inputs for beat triggering or audio modulation of lights • Sensitivity control • pre-settable sensitivity levels for each channel • Front panel LEDs mimic light display.
Great For Parties, Shop displays and special lighting effects.

Universal High Power Amplifier Module
(See SC Dec'87)

High power rugged reliable design featuring low distortion and inbuilt speaker protection All components, including output transistors mount on a single PCB. Suitable for high quality guitar amp, public address or in a high fidelity stereo amplifier. Kit includes angled heatsink bracket, main heatsink and unlike other kit suppliers, the in-built Polyswitch for loudspeaker protection.



100W Version K 5140 $69 **150W Version K 5150 $99**

General Purpose Pre-Amp

This unit contains all necessary components to complete:- • A Phono Pre-Amp with RIAA freq. response • A tape Pre-amp with NAB response • A microphone Pre-amp with either 40 55 or 80db of gain. • Or a Pre-amp for just about anything!
Power 10-40V DC High 100db Ripple Rejection.

K 5510 $18.50

Active Direct Injection Box
(See EA Oct'87)

Eliminates Annoying Hum Pick up

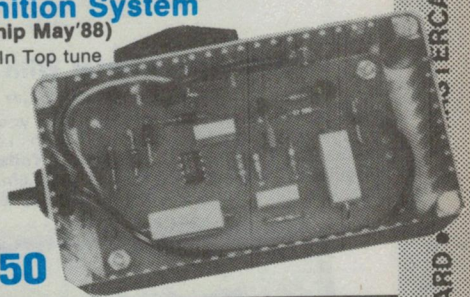
Converts high impedance unbalanced inputs to low impedance balanced outputs Used in studios, music, PA industry to convert high impedance devices i.e. electric guitar pickups, synthesizer etc. to low level balanced outputs to be fed over long lines.
Features: Professionally screen printed • Earth isolate switch • 15db pad • Phantom powering plus internal 9V bat.

K 5550 $45.00

High Energy Ignition System
(See Silicon Chip May'88)

Keep Your Car In Top tune

Extends the life of plugs & points, increases power & improves fuel economy. Suits 4,6 & 8 cylinder engines. Install one into your car & start saving $$$ from the very first day.



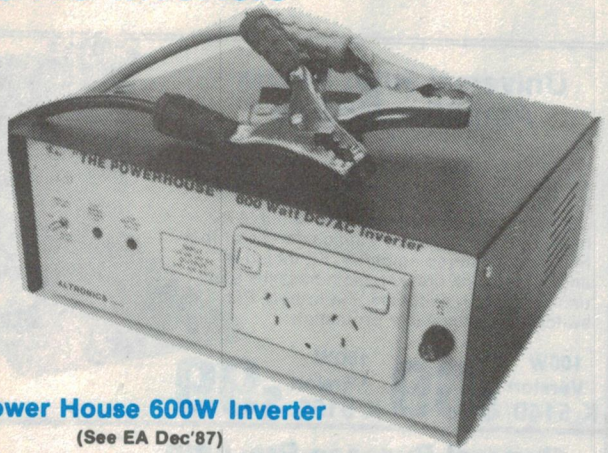
K 4015 $43.50

Line Filter & Conditioner
(See EA July'88)

Simple, easy to build & low cost too - Helps eliminate those annoying clicks & pops on your stereo & TV when the fridge compressor switches on & off. Helps prevent computer crashes from power spikes & glitches. Altronics customised version housed in strong sturdy Jiffy box nickel sprayed for EMI shielding.

K 6040 $39.50

Go anywhere 240V Mains Power from your car or truck battery with these fantastic DC to AC Inverters



Power House 600W Inverter

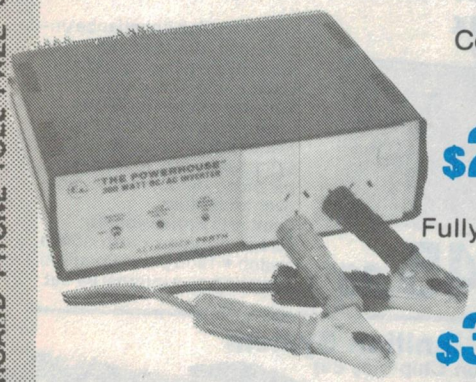
(See EA Dec'87)

A must for farming, camping, mining, boating, remote settlements and wherever else 240W power isn't available.

Features: Strong custom steel chassis • Industrial grade power coat finish • Can be configured to operate off either 12V and 24V DC • Very little internal wiring • Manual or Auto start facilities • Low battery cut out • Compact Toroid transformer.

Fully Built & Tested

K 6770 KIT VERSION	K 6774 12V INPUT	K 6775 24V INPUT
$425	$525	$525



Complete Kit

K 6750

$279.00

Fully Built & Tested

K 6755

$379.00

300 Watt Inverter With Auto Start

Operates From 12V Car Battery

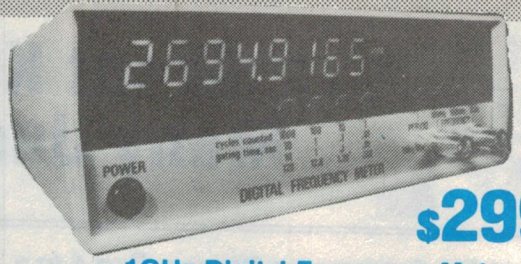
Features: Auto start draws power from your battery only when appliance is plugged in and "turned on" i.e. battery can be left permanently connected if required. • **Voltage regulated** • **Current Regulated** • **Current Overload** unit self limits — Single PC Board construction — easy to build as there is very little internal wiring.

40W Inverter For Small Appliances

(See EA Aug'85)

Features: 2 Modes of operation. Standard 40W Inverter or battery charger. Fixed or variable frequency allows for precision control of frequency dependant devices. Operates from 12v car battery.

K 6705 $89.00



K 2515

$299.00

1GHz Digital Frequency Meter

(See SC Nov'87 Jan'88)

This superb 1GHz Frequency Meter will out perform many other instruments twice its price.

Features: Professional machined and screen printed red perspex front panel • Easy to asemble and construct • No special tools required • Bright Hewlett Packard 8 digit display • Electronic switch latching • High performance IC's • High Quality Components.

Transistor FET Zener Tester

(See EA Feb/Mar'88)

New updated circuit incorporates facilities for testing transistor FETs and Zeners etc.

Features: • Gain • Leakage • Breakdown Voltages • Zener Voltage • Polarity — NPN/PNP

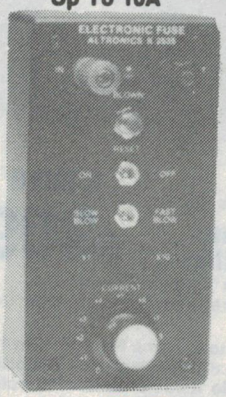
K 2527 $49.95

This natty service aid allows you to track down short circuits without continually blowing fuses

DC Electronic Fuse

(See EA Nov'87)

Replaces Any Size Fuse Up To 10A



K 2535 $39.50

Low Ohms Adaptor For Your DMM

(See SC Feb'88)

Measure Accurately Down To 50 Milli Ohms!

As we all know it's difficult to obtain accurate resistance measurements below 50 Ohms or so with conventional multimeters. This natty little adaptor plugs directly into your DMM via. in-built banana plugs enabling quite accurate measurements to 50 Milli Ohms and less. Full instructions provided.

K 2518 $24.99

8 Way Remote Control

(See EA June July'86)

Convert your TV, CD, VCR etc to be operated remotely from the comfort of your armchair. Up to eight separate functions can be switched with this infrared remote control.

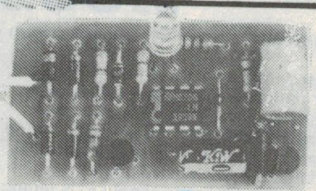
Control Your TV Or Stereo From Your Chair

Added Facility

Apart from above - allows for control of On/Off, Mute and volume control.

K 1830 $125.00

K 1840 $45.00



Telephone Off Hook Indication

(See SC Nov'87)

Use where 2 or 3 phones are connected on the one line. If one extension is in use a LED will flash in each of the other extensions. Requires no external supply. Runs off the telephone line. One module required for each phone.

K 1400 $9.95

An introduction to hifi — Part 20

Loudspeaker Systems — 1

Having discussed, in general terms, loudspeakers and their relationship to the amplifier, it now remains to look more closely at some of the matters mentioned and to note how they influence the design parameters for the many loudspeaker systems that are currently on offer in the hifi marketplace.

by NEVILLE WILLIAMS

If we were concerned mainly with median (or speech) frequencies, as was the case in the 1920's, sound propagation would present relatively few difficulties. By simply facing a typical dynamic loudspeaker in the general direction of the audience, most of the listeners would hear most of the frequencies reasonably well. (See Fig.3, Pt.19).

But the lower, or bass, frequencies – particularly those below about 300Hz – pose a special problem as their gradually increasing wavelength becomes comparable to, or greater than, the principal dimensions of the cone. With the cone moving in a given direction for a progressively longer period during each successive half-cycle, air under pressure on one side of the cone has time to flow around the edge of the housing to relieve the partial vacuum on the other side.

As a result, instead of propagating a pattern of low frequency sound waves into the surrounding atmosphere, much of the system energy is wasted in simply pumping air back and forth in the immediate vicinity of the loudspeaker.

Frequency wavelength

A direct front-to-back path for bass energy is aptly described in technical literature as an "acoustic short circuit". More specifically, it becomes evident at and below the region where a half-wavelength approximates the mean path length from the front to the rear of the cone.

By way of verification, data published by Briggs/Wharfedale around 1950 (Fig.1) indicates that the effect begins to show up below about 1000Hz for a good quality unmounted 30cm driver. By about 256Hz, or middle-C on the musical scale, the acoustic output is down by 10-12dB, and by 18-20dB an octave below that.

Fig.2 presents this in a generalised form for any comparable moving coil driver. The response is nominally level down to the acoustic short circuit region, where it rolls off into a downward slope equivalent to about 6dB/octave.

The natural resonance of the coil/cone system is likely to occur part way down the slope, at which point it tends to steepen to 12dB/octave or more. The exact shape of the curve around the resonance region depends on the individual driver and the amount of electrical damping imposed by the associated amplifier, but there is likely to be a plateau, as in Fig.1 or a peak of greater or lesser magnitude, as shown in dashed in Fig.2.

For these and other related reasons, physically large loudspeakers with (normally) a lower frequency cone resonance usually exhibit somewhat better bass response, unmounted, than their smaller counterparts. While it is not normal to use dynamic loudspeakers in this fashion, Yamaha did, at one stage, feature unusually large cones in some of their music systems and electronic organs.

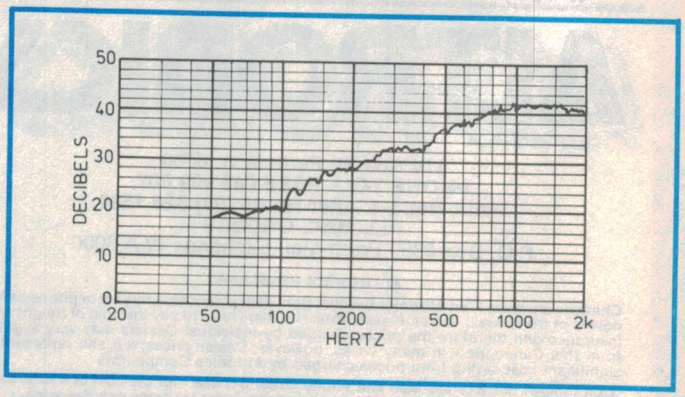


Fig.1: The free field response of an unmounted 300mm driver, from "Loudspeakers" by G.A.Briggs. The 6dB/octave slope is evident below about 1kHz.

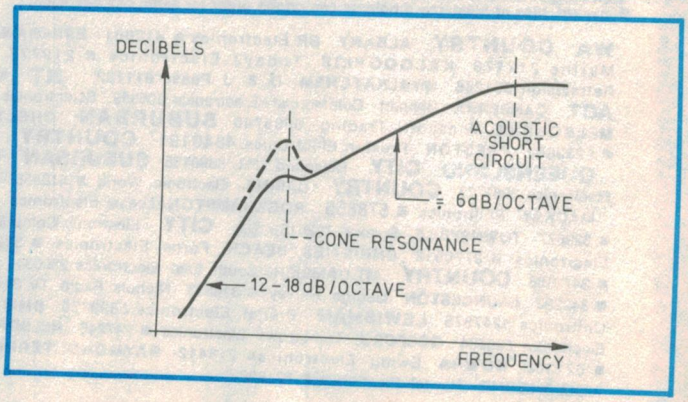


Fig.2: The behaviour of an unmounted bass-end driver in generalised form, showing the roll-off below the acoustic short-circuit region and the effect of cone resonance.

Role of baffling

However the most meaningful way to push the acoustic short circuit region downwards in frequency is to mount the loudspeaker on a stout baffle board, or in a rugged cabinet of some kind – the larger the better – to ensure a much longer air path from the front to rear of the cone.

The practical result of so doing is to transform the loudspeaker into an item of furniture, which then has to be embellished and accommodated in the listening room – with good grace or otherwise! Apart from a few secondary considerations, it all has to do with the region below about 300Hz, with which this present article is principally concerned.

In the mono era, with only one channel to worry about, the approach favoured by dedicated hifi enthusiasts was to invest in an expensive high efficiency 30-38cm (dia) driver – Wharfedale, Goodmans, Celestion, Rola, American Magnavox, Jensen, etc., – most exhibiting a natural cone resonance of around 45Hz; and then to baffle it as generously as could be arranged.

For some, the ultimate was to install it in a dividing wall, or across an unused fireplace, or in the door of a large built-in cupboard, thereby creating a virtually infinite baffle.

For others, it meant a large, suitably finished baffle board, at least one metre square, free-standing with rear support extensions or fixed across a corner to increase its effectiveness. Still others settled for a heavy wooden rectangular or corner cabinet, variously open, sealed or vented, of around 250 litres (9 cu ft). A few devotees – not this author – even opted for hollow sand-filled panels or brick structures of comparable dimensions!

Most such combinations sounded impressive, because the de-luxe drivers, with their large cones and long-travel voice coils were able to move plenty of air at low frequencies, without obvious distortion. The large magnet system and (normally) a low impedance amplifier ensured good damping, with little or no resonant bass "boom". Most such baffle arrangements preserved the useful response to below 100Hz, with the natural cone resonance extending it to at least 45Hz, maybe even down towards 30Hz in some cases. It was all very challenging, rewarding – and relatively non-critical!

Unfortunately, the same could not be said for inexpensive look-alikes from the same period. Economy 30cm loudspeakers, with limited magnet systems, could not use long-travel voice coils and still retain reasonable sensitivity. In consequence, the suspension had to be fairly stiff to keep cone travel within bounds and that usually meant a cone resonance in the region 65-75Hz, leading to a rather "thumping" or "boomy" low end. The most obvious result was the infamous "one note bass" of many old-style console radiograms.

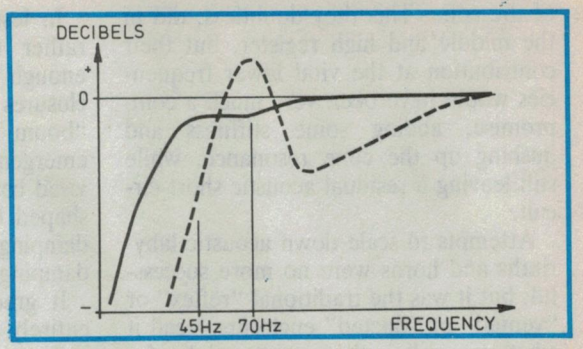


Fig.3: A generously baffled quality driver with a low, well damped resonance can produce an agreeably sustained bass response (solid curve). But poor baffling and a poorly damped resonance at around 70Hz (dashed curve) can produce a "thumping" sound.

Fig.3 illustrates the difference between the two situations. The solid curve depicts a high quality driver, with a well damped resonance at 45Hz, generously baffled. The dotted curve is for an inexpensive driver, with a poorly damped 70Hz resonance and limited baffling.

Changes for stereo

The widespread adoption of stereo completely changed the situation. Hifi devotees might have been prepared to accommodate one generously proportioned loudspeaker system but certainly not two, especially as they had to be placed symmetrically to the front left and right of the listening position. The pressure was on, therefore, to come up with compact, self-contained loudspeaker systems which would offer comparable quality and bass response to that of the familiar mono monsters.

And this is where designers and enthusiasts alike ran into difficulties – and seemingly endless arguments – during the first decade or so of the stereo disc era.

It was clearly not sufficient merely to reduce the size of traditional baffles or open-back structures because, by the time they had been made small enough to be aesthetically acceptable, the acoustic short circuit roll-off had been pushed back up towards 300Hz, with the 30-40Hz region some 20dB down.

Then what about a compact, completely sealed enclosure, misguidely referred to by some as an "infinite" baffle? While this may indeed contain and isolate back radiation from the cone, it was (and still is) anything but infinite in its effect on system behaviour.

In particular, the body of air trapped in the enclosure acts as a supplementary spring tending, along with the normal suspension, to return the cone to its median position. The added "stiffness" has the effect of raising both the frequency and the "Q" – or the prominence – of the cone resonance.

In the days of 250-litre enclosures, the end effect was relatively minor. But attempts to mount the same kind of 30cm driver in a scaled down or compact sealed enclosure (around, say, 50 litres) could see the system resonance pushed up into the "boom" region around 75Hz.

Sundry attempts were made to counter the effect by such measures as padding the inside of the enclosure, adding internal absorbent drapes, filling it with wool or synthetic fibre and/or drilling an array of small holes through one or more of the surfaces. While such measures may have helped to reduce internal "standing wave" effects at median and high frequencies, their contribution to the low end performance was small.

Baffles & labyrinths

An approach that attracted some attention was the so-called "baffle" (Fig.4) which was neither fully sealed nor fully open. Behind the 30cm loudspeaker was a succession of caneite

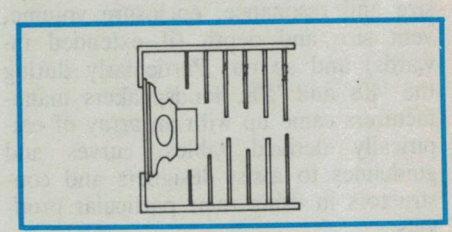


Fig.4: The so-called "Boffle" system used Caneite panels to break up mid-frequency standing wave effects, but bass performance was a compromise.

spacers and panels, with circular holes as indicated, which were meant to intercept and absorb radiation from the rear

of the cone. This they doubtless, did in the middle and high register, but their contribution at the vital lower frequencies would have been very much a compromise, adding some stiffness and pushing up the cone resonance, while still leaving a residual acoustic short circuit.

Attempts to scale down acoustic labyrinths and horns were no more successful; but it was the traditional "reflex" or "vented" or "ducted" enclosure – call it what you will – that generated by far the greatest confusion and controversy. The principle dates back at least to the later '30s, when it was taken up by the US Jensen company as an adaptation of the Helmholtz resonator.

The reflex enclosure was/is visually similar to a sealed enclosure except for an extra cutout, usually in the front face, often about the same area as the active cone and sometimes extended inwards to form a short duct or tunnel. The basic idea is to take advantage of the acoustic resonance that occurs between the compliance of the air in the enclosure and the mass of that air in and around the vent.

It transpires that the phase of the energy radiated from the vent is shifted by 180°, relative to the rear of the cone, so that it tends to reinforce rather than to cancel that from the front. And because the radiation from the rear of the cone is utilised rather than absorbed, as in a sealed enclosure, it offers a considerable potential advantage in terms of acoustic low-end efficiency.

By suitably relating enclosure resonance to that of the driver, the overall effect, ideally, is to smooth and extend the low-end response to well below the natural driver resonance while, at the same time, flattening the impedance curve.

For a vented system to function as intended, there must be proper correlation between things like loudspeaker size and resonance, enclosure volume, vent size and depth (if extended inwards) and so on. Particularly during the '40s and '50s, loudspeakers manufacturers came up with an array of empirically derived tables, curves and guidelines to assist designers and constructors in using their particular products.

There were obvious discrepancies in such information but it seemed to work out well enough in practice – while ever the emphasis was on large enclosures. It was when attempts where made to scale down the systems for the stereo market that the empirically derived guidelines really came unstuck.

In less than huge systems – e.g. 150 rather than 250 litres – there were enough "lemons" to earn for reflex enclosures a reputation as potential "boom boxes". This, in turn, saw the emergence of dubious empirically devised corrective measures such as oddly shaped baffle cutouts or ports, internal damping curtains or partitions, and damping applied across the vent.

It gradually became evident that an entirely new approach was necessary to system design, generally. Rather than choose a fancied driver and create an enclosure around it, the designer should first define the desired end product in basic terms: size, bandwidth, power handling, sensitivity, etc. This done, the most promising option could then be targetted – vented, sealed or anything else – and designed as a whole, with the choice of driver becoming an essential part of the design procedure.

Modern systems

The majority of present-day loudspeaker systems are either vented or sealed, with a wider understanding of the latter being commonly credited to Edgar M. Villchur, founder of AR Inc. Certainly, Gilbert Briggs of Wharfedale recounts an unofficial "contest" at the New York Trade Fair of about 1955, between one of his classical 9 cu ft enclosures and a much smaller AR "acoustic suspension" model. Says Briggs:

"I was surprised at the amount and quality of the extreme bass which came from the AR model (although) the wick had to be turned up to get it".

The essential logic behind the fully sealed, acoustic suspension approach is that the bass-end driver should be initially designed with a long-travel, highly compliant (low stiffness) coil/cone suspension system, having an unusually low (unmounted) resonance frequency – commonly in the region 20-25Hz. Such a driver is totally unsuitable for use in an open-back situation, because of the possibility of distortion and even physical damage due to excessive cone travel.

In a suitable sealed enclosure, however, the stiffness of the entrapped air can add sufficiently to that of the mechanical suspension to raise the fundamental system resonance to an acceptable and convenient 40/55Hz and subject to a carefully selected order of electrical and acoustic damping, in the latter case by internal absorbent padding and/or filling.

There is more to it, however, than just mounting a low resonance driver in a likely looking damped enclosure – as emphasised in a paper presented to the 1984 AES Melbourne Convention entitled: "Practical Design of Optimal Sealed-Box Loudspeaker System". In it, Messrs Wiebell and Bywater analyse the relationship between various design considerations such as: available drivers, optimum enclosure volume, system "Q", damping, frequency response and acoustic efficiency.

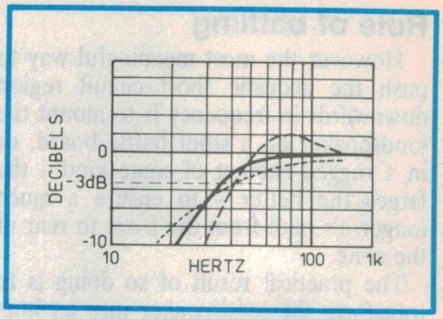


Fig.5: The bass-end response for an optimally designed sealed enclosure (solid curve). The dashed curves show the effect of too small and too large an enclosure.

For example, the solid curve in Fig.5, derived from the paper, shows the bass-end performance of a theoretical, optimally designed acoustic susupension system. The response rolls off smoothly through −3dB at 35Hz – low enough to cope with all normal bass response requirements. The dashed curve, showing the onset of peaking, is symptomatic of a too-small enclosure with too high a "Q". The dotted curve, resulting from an enclosure too large for the particular driver, indicates an actual loss of response over the useful range and reduced protection for the coil/cone system at sub-audible frequencies.

Philips have done much to popularise the fully sealed approach in Australia and elsewhere, in recent years. (e.g., "Building Hi-Fi Loudspeaker Systems" 7th. edition, 1980 by M.D.Hull). Fig. 6 shows the anechoic response of their 3-way System 16 (pp 179-181) using a 30cm woofer with a bass resonance (unmounted) of 25Hz. In the 50-litre sealed enclosure, this rises to around 55Hz, with the response essentially flat down to that point but with still useful output in the 30-40Hz region.

Allowing for timber thickness, the space occupied by the drivers and any internal braces or compartments, a 50-litre (1.8 cu ft) system need be nothing more than a modest free-standing enclosure, with a stereo pair being much less likely to be cited as a reason for divorce than a brace of their 250-litre ancestors!

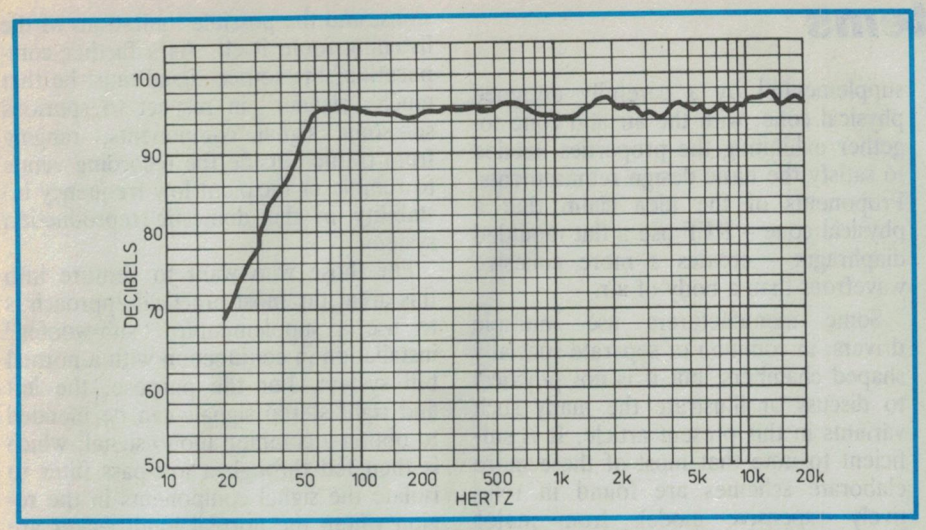


Fig.6: The frequency response for a modern 3-way 80W sealed system housed in a 5-litre enclosure, designed by Philips.

Small sealed enclosures

To meet the inevitable demand for still smaller systems, designers have the logical option of using progressively smaller low resonance bass drivers. Since smaller-area cones exhibit less loading from the entrapped air, it is possible to use them in smaller volume enclosures, while still preserving an acceptably low system resonance and extended bass response.

Nowadays, woofers and/or bass/mid-range drivers are commonplace with nominal diameters of 35, 20, 15 and even 10cm, providing to prserve an acceptable bass response – but at a cumulative price.

As noted earlier, large area cones (30-38cm dia) are able to couple to or "pump" a fair volume of air, to create suitably loud bass sounds. Retaining the pump analogy, smaller area cones need to travel through a proportionately greater distance for equal loudness at low frequencies. Not only does this demand long-travel suspension, but also adequate clearance in the air gap and a very long – or a very short – voice coil, such that a given number of turns will always be present in the magnetic field. (See Fig.7).

The efficiency of physically small drivers must inevitably suffer and if, as normal, they are associated with separate mid/high frequency units, it must be assumed that the sensitivity of these will, in turn, be restricted to preserve proper overall balance. For such reasons, the acoustic efficiency of practical sealed systems tends to diminish with size such that, for a given electrical drive, smaller systems sound progressively less loud than larger ones.

This must be kept in mind when assessing performance specifications. A diminutive system may well be rated for a surprisingly high maximum power input. It may, in fact need it, to provide an adequate peak level in anything but a small room!

In summary, modern sealed, acoustic suspension systems are able to provide excellent low frequency (and overall) sound without needing to be embrassingly large. But if you have a choice, and assuming equal design merit, favour a moderately large system rather than one that is needlessly small. Its design will almost certainly have involved less stringent compromises.

Modern vented systems

The early guidelines adopted for reflex/vented systems needed little skill to interpret, but they were basically flawed because they did not take into account all the operative factors.

Confusion continued until the publication of a landmark paper by Australian engineer Neville Thiele, entitled "Loudspeakers in Vented Boxes" *Proc. IRE (Aust)* Vol.22, No.9, Aug.1961). It was based on the realisation that a reflex or vented system was really a high-pass audio filter, and that it could be analysed and resolved on that basis. His work was subsequently taken up and expanded by others, notably Richard Small, an American engineer then resident in Australia.

As with the sealed system, Thiele showed that it was inappropriate to start off with a fancied bass driver and attempt to design a vented enclosure around it. Many drivers were simply not suitable for the purpose. Not only was the driver an intimate component of the

overall design, but driver parameters were involved other than simply cone diameter and resonance. (For a more detailed explanation of the approach, see "Vented Enclosures, The Gospel according to Thiele and Small", by David B.Weems, *Electronics Australia*, Sept. '80.

As it turned out, the up-dated design procedure established by Thiele is more suited to engineers than to hifi hobbyists. More to the point, however, loudspeaker and systems manufacturers have since translated it into computer programs which allow them to investigate and predict the bass-end performance of particular drivers and enclosures with a high order-of accuracy. Largely as a result of all this, reflex enclosures have won back a lot of the support that they were in danger of losing to the (formerly) less ambiguous acoustic suspension concept.

The above methodology holds for all reflex enclosures, from large systems through to the very compact ones based on suitably designed, small diameter drivers. But the same observation applies as for sealed systems, mentioned earlier: given a choice, and assuming equal design merit, favour a larger system rather than one that is needlessly small.

Large or small, it is again important for hifi hobbyists or bargain hunters to understand that there is much more to a reflex enclosure than a polished cabinet with an extra hole in the front and fitted out with likely looking drivers. Whether in the form of plans, a pre-cut assembly kit or the finished item, there needs to be some assurance that the whole project has been professionally designed in accordance with the accepted Thiele procedure or "alignment".

It should also be noted that a number of valid elaborations of the basic vented concept have emerged as, for example, the use of a so-called "passive radiator" (e.g. System 19 in "Building HiFi Speaker Systems"). This involves the use of what appears, at first glance, to be an extra bass driver with a cone which is often quite similar to that of the normal driver. In fact, it turns out to be a passive or "drone" cone, suitably weighted and suspended in a loudspeaker housing in the usual way, but minus a voice coil and magnet system.

The idea is that, instead of using the air in an open vent or duct as one component of the acoustic resonance, it is supplemented by a carefully designed physical cone, with the air and cone together exhibiting the properties needed to satisfy the basic design requirements. Proponents of the idea claim that a physical cone – KEF use a flat moulded diaphragm – creates a more cohesive wavefront than a body of air.

Some manufacturers use multiple drivers, in common or separate specially shaped chambers; but it is not practical to discuss or illustrate the many such variants in this present article. It is sufficient to note that most of these more elaborate schemes are found in relatively expensive models from major manufacturers and are usually backed by solid research. As such, they can be expected to perform well and it becomes a matter of deciding whether the outlay is justified, based on listening tests and reviews in the technical press.

One other matter warrants brief mention at this point, namely that of subwoofers. Loudspeaker systems such as those already discussed, which preserve useful output down to about 30Hz, are normally considered adequate for even demanding hifi requirements. Inevitably, however, there are those who are concerned about the occasional sub-octave organ notes and possible sub-harmonics of percussion sounds, all of which tend to be felt rather than heard. Aren't they also part of the music?

Perhaps they are, but the difficulties of extending the response of ordinary systems downwards by another octave are forbidding, when considered against the musical dividend, cost and dimensions, and the possible limitations of the listening room itself. As a further complication, the source signal must be that much "cleaner" in respect to spurious sub-sonic signal components, ranging from traffic outside the recording venue to rumble or incipient low frequency instability in the domestic reproduction system.

For those who want to venture into this area, the most practical approach is to use a supplementary "sub-woofer" installation in conjunction with a normal hifi system. For the purpose, the left and right stereo signals can be blended to obtain a common mono signal, which is then fed through a low-pass filter to isolate the signal components in the region where the normal loudspeaker are rolling off.

Because these very low frequencies tend to be common to both channels and subjectively non-directional anyway, mono reproduction is entirely adequate. The common signal can therefore be fed to a separate mono amplifier and thence to a special sub-woofer loudspeaker system, hidden or disguised as something else, anywhere in the listening area. The sound level from it can be adjusted to suit the occasion and the program material by simply varying the gain control on the sub-woofer amplifier.

The idea of using a separate mono woofer may also be attractive to music lovers who, while not directly interested in an extra octave, find it difficult to accommodate anything but small main loudspeakers. A separate concealed woofer, able to selectively reinforce frequencies below about 100Hz, can add real "body" to the overall sound.

(To be continued)

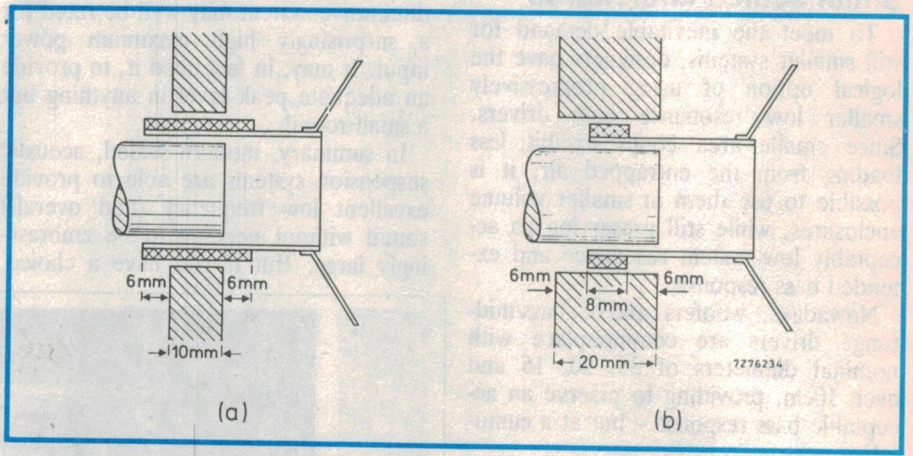


Fig.7: As illustrated in M.D.Hull's manual "Building HiFi Speaker Systems" (Philips), long travel voice coils may use either (a) a long coil in a short magnetic field, or (b) a short coil in a long magnetic field, to achieve linearity over the full cone travel.

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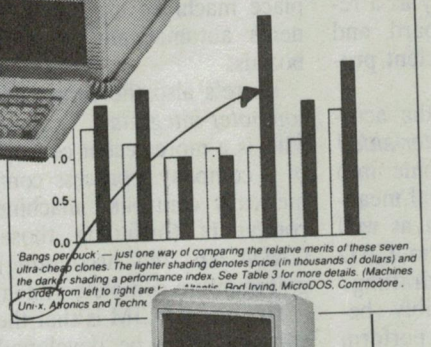

'Bangs per buck' — just one way of comparing the relative merits of these seven ultra-cheap clones. The lighter shading denotes price (in thousands of dollars) and the darker shading a performance index. See Table 3 for more details. (Machines in order from left to right are [illegible] Red Irving, MicroDOS, Commodore, Uni-x, Atronics and Techno

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Performance.
[illegible] The Uni-x is fastest overall, providing a 50 per cent boost over the Technology Interface due to the V20.

Display.
[illegible] delivered with a nice INTRA tilt/swivel amber screen. The [illegible]

Cost Effectiveness.
As you might expect, the do-it-yourself Uni-x comes up trumps with its low cost and relatively high performance.

Specifics.
The Uni-x features a delightfully small motherboard. It has employed a VLSI component to replace the Intel 8253 timer, 8255 PPI, 8237 DMA controller and several other components. This reduced the component count and a simplified motherboard serves to reduce costs.

. . . see for yourself in the full Report in the October '87 issue, or ring us for a copy.

Special Feature:

Our annual CAD update

It's time again for our annual look at what's happening in the use of computers as tools for design, drafting and related activities. By way of introduction, and for those who haven't looked into this area before, here's a quick rundown on the concepts and terms you'll meet on the following pages.

Originally, the term CAD stood for *computer-aided design* – using a computer running suitable software as a tool for the engineering design of any desired product or system. However in the last few years the term has also acquired the rather narrower meaning of *computer-aided drafting*, where the computer system is used largely as a replacement for a drawing board and drafting machine – for the efficient production of plans and drawings.

Because of this ambiguity, the acronym CAE (standing for *computer-aided engineering*) has tended to come into use, to cover the broader original meaning of a tool to assist in *design* as well as drafting. But the older term CAD still tends to be used for *both* "drafting" and "design" packages, possibly because many CAE packages also perform drafting, as an integral part of their operation.

As a result, it's wise to work on the basis that not all CAD packages are alike. Some are basically just drawing and drafting tools, while others are much more powerful and able to perform things like automatic PCB track routing, circuit analysis and simulation.

Another term you'll come across nowadays is CAM, standing for *computer-aided manufacturing*. This is the use of computer-controlled machine tools and other production equipment. Associated with CAM is the term CNC, short for *computer numerical control*, used to describe machine tools which accept programs from, or prepared using, a computer. Sometimes CNC is shortened to NC, for *numerically controlled*.

An example of the way CAM and CNC machines are being used in the electronics industry are the pick-and-place machines used to mount components automatically on printed circuit boards.

There's also the term CIM, short for *computer-integrated manufacturing*. This is a more recent concept, where all of a company's process controllers, numerically controlled machine tools and computers (including those used for CAD/CAE and accounting) are integrated into a complete system.

The idea of CIM is that the design for a product can be developed using the engineering department's computer, and drawings prepared. Then the planning department's computer can plan the manufacturing schedule, and the purchasing department's computer can order the parts. The production department's computers can then program the CNC machines to perform the manufacturing, and finally the accounts department computer can prepare the shipping documents and invoices.

It all sounds great in theory, perhaps, but in practice CIM is still some way off.

When CAD software packages were first developed, you needed a fairly powerful mainframe computer to run them. This still tends to be the case with the most powerful CAD systems, such as those used for the design and simulation of new integrated circuit chips. However quite a lot of lower-level CAD can be performed using packages running on personal computers - such as the IBM PC/AT and compatible machines.

Applications in electronics which can be performed using these PC-level CAD packages include circuit schematic drawing and design, circuit analysis and simulation, PCB design (both manual and automatic routing) and preparation of programs for machine tools and robots such as PCB pick-and-place machines.

Generally the basic hardware requirements for this type of work are a PC-AT level machine with at least 640K bytes of memory, a reasonably fast 20Mb or 40Mb hard disk, an EGA or better graphics adaptor with fairly high-resolution RGB colour monitor, and either a high-resolution dot-matrix (or laser) printer or a plotter. A mouse or graphics tablet can also be very desirable.

A term you'll often find used in connection with the more elaborate CAD/-CAE systems used in electronics is *netlist*. This is a data file, usually generated by a *schematic capture* or circuit drawing program, which consists of a shorthand description of the components used in the circuit and their interconnections. The netlist file is the form in which the "circuit" is passed to a circuit analysis or simulation program, for analysis, or to an auto-routing program for generation of the appropriate PCB pattern.

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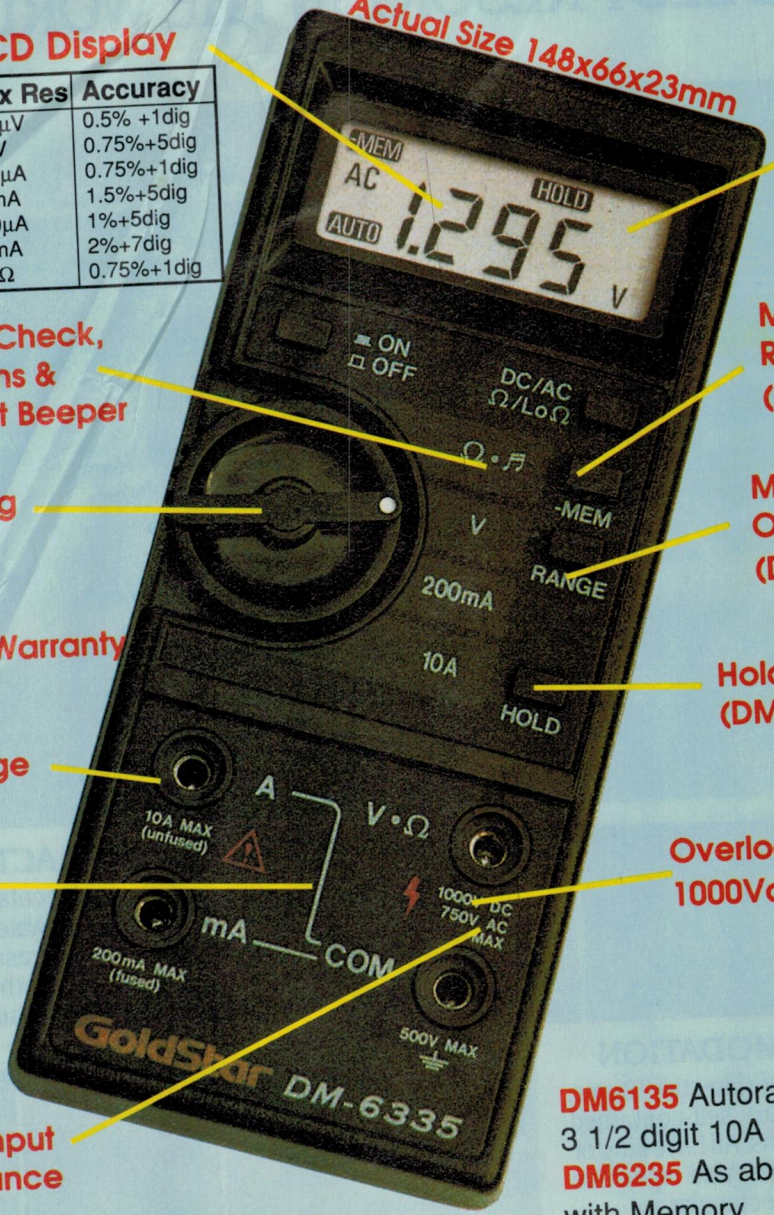

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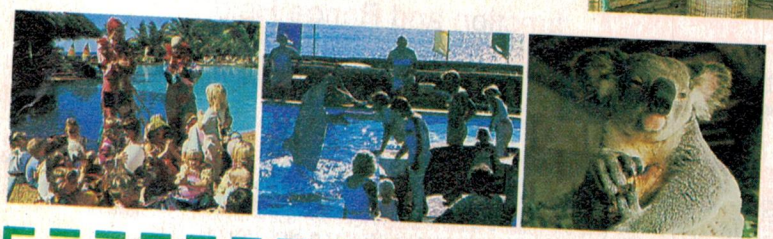

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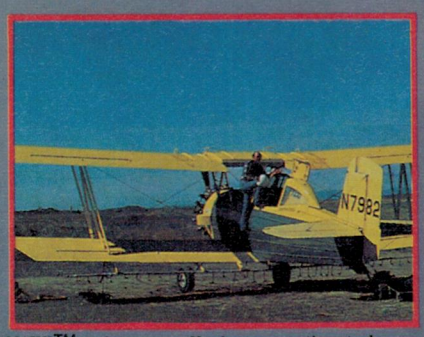

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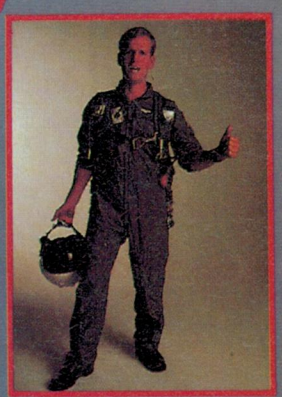

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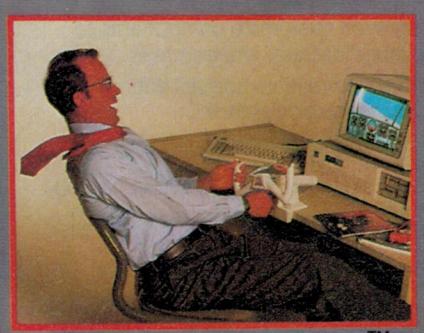

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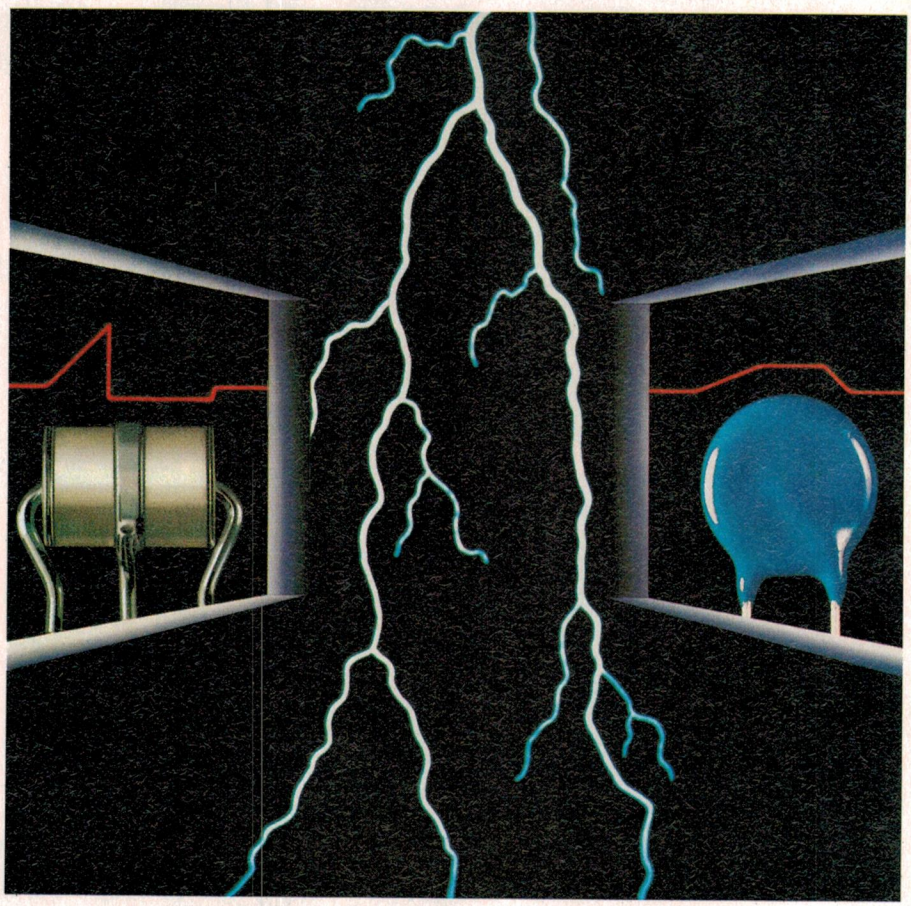

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CAD Feature:

New IBM CAD package transforms PCB design

A new CAD package for PCB design being marketed by IBM for use on a wide range of its computers (including the RT/PC) is claimed to allow a dramatic reduction in the time needed to design complex boards.

In the mid seventies, design of a complex printed circuit board with 70 integrated circuits took about three weeks. Today that same board can take less than a week.

Making this possible is a new package combining CBDS (Circuit Board Design System), developed by Bell-Northern Research of Canada, and CIEDS (Computer Integrated Electrical Design Series Simulators). Marketed internationally by IBM, the recently released CIEDS/CBDS package Version 4 provides powerful, easy to use schematic capture and design entry capabilities plus an object-driven man-machine interface (MMI) for circuit simulation, board layout and routing with on-line documentation and design violation checking.

According to IBM systems engineer Dino Calapai, "With MMI, the user selects the object to be acted upon and then the operation is performed. This leaves the user with the same environment to perform other related functions. More frequently used commands are available through predefined programmed function keys, via IBM's Lighted Programmable Function Keyboard".

Mr Calapai said CIEDS/CBDS Version 4 eliminated the traditional circuit prototyping process. Schematics can be drawn on CIEDS Design Capture, which has a selected component library supporting Texas Instruments, Signetics and National Semiconductor devices.

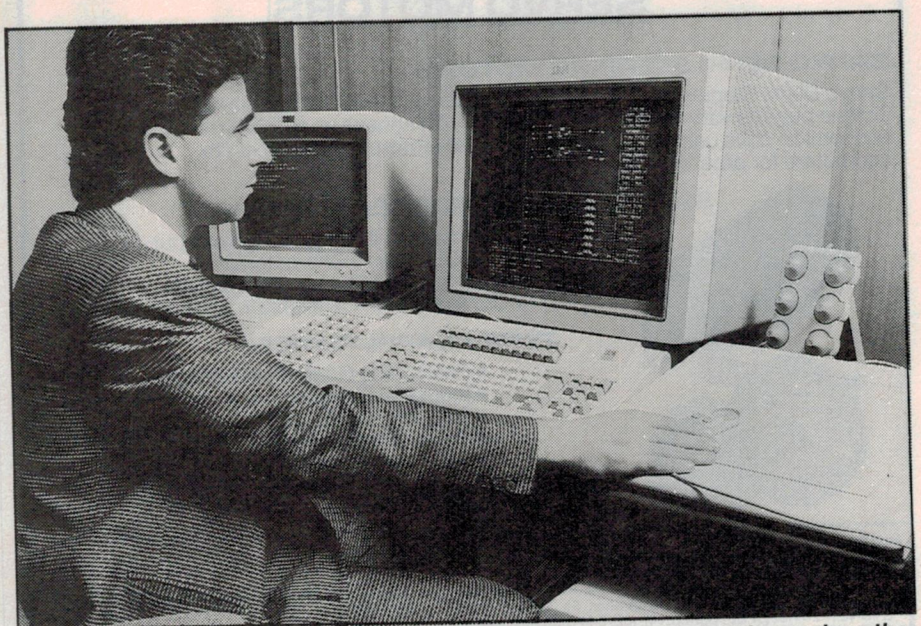
The CIEDS Analog-Digital Simulator allows for simultaneous simulation of analog sampled data circuits with their digital control logic. Simulation times are minimised through use of piecewise linear models for all non-linear devices and event driven digital primitives. Results can be evaluated with a display utility provided in CIEDS/Simulation Base.

The CIEDS Design Simulation Base provides a comprehensive and interactive multi-window output display for the designer to view the results of a simulation. Highlights include an easy-to-learn command menu using a mouse to eliminate the need to memorise complex keystroke entry, and the ability to display a chosen portion of a schematic. This allows nets to be selected for viewing in the waveform and tabular display windows.

According to Mr Calapai, "CIEDS replaces many of the sophisticated instruments used by engineers in the traditional circuit prototyping process. A circuit schematic may be displayed in the CIEDS schematic window, input waveforms are then defined for each input to the schematic. The mouse is used to select circuit nodes to be displayed in the waveform and tabular display windows. Circuit data may be displayed in the time and frequency domain, where node values can be represented in decimal, mnemonic and boolean formats. This feature may functionally replace instruments such as 'scopes, spectrum analysers, logic analysers, phase meters and various development systems."

After a top-down design is completed using approximate delay values, a utility is available for circuit re-verification using actual delay values for the parts that have been selected in the final design.

Another feature is the CIEDS Beha-



IBM systems engineer Dino Calapai uses a mouse to help him review the schematic of a printed circuit board he is designing on CIEDS/CBDS.

vioural Simulator, which allows the designer to start with the design definition of an integrated circuit or printed circuit board, and begin testing parameters at the architectural, register and gate system level.

The CIEDS Logic Simulator is a complementary simulator to the CIEDS Behavioural Simulator. While the latter is used during the "what if" stage of the design process, CIEDS Logic Simulator is used to refine the design and fill in the details.

Switched capacitor networks can be simulated in the time and frequency domains using the CIEDS Switched Capacitor Simulator. This frequency analysis computes amplitude and phase response including sample and hold effects and continuous input/output coupling. In addition it accurately simulates sensitivities to component tolerances and parasitic capacitances, group delay, amplitude slope distortion due to nonlinear components and noise density. Time and frequency responses can be evaluated with the display utility provided in the CIEDS Design Simulation Base.

CBDS is basically an interactive graphic design tool that can speed the design and manufacture of printed circuit boards and thick film hybrid chips. It has a great many available functions, including capability for schematic entry and generation of manufacturing data.

The CBDS system is composed of four modules: a Component Database, a schematic entry module (LOKI), a physical layout subsystem (SPRIG) and a manufacturing data generator (CAM).

Mr Calapai said that designs can be entered through the LOKI schematic capture program or alternatively via the CIEDS/CBDS interface. LOKI can be used as a stand-alone subsystem. Circuit components and their symbols are called up from the predefined component database. Using the IBM 5080 Graphics System as a principal design workstation, CBDS utilises advanced function graphics combined with the MMI to enhance end user productivity.

CBDS offers a starter component database of approximately 10,000 devices. All component data and associated symbols may be centrally created and controlled, for standardisation. Additional components may be defined easily as the need arises.

The SPRIG physical layout subsystem is capable of automatic placement and routing of advanced multilayer PCBs, with high density surface mounted components and hybrid packages. SPRIG also offers various optimisation routines and online violation checking for reduction of PCB vias, track length and optimisation of routing to multi-gate IC packages.

CBDS also supports full back-annotation facilities, so that modifications to PCB data are transferred back to the circuit schematic. Design integrity is therefore maintained.

CBDS also offers the CAM module for generation of manufacturing data. CAM is capable of producing all PCB/hybrid artwork including overglaze and silk screen legends, in Gerber photoplotter format and standard pen-plotter format. NC drill tapes and auto-insertion reports are automatically generated, along with a bill of materials report comprising supplier and costing data.

Mr Calapai said that CIEDS/CBDS greatly reduces long lead times usually associated with circuit design, and virtually eliminates traditional prototyping procedures.

CIEDS/CBDS runs under the VM operating system on a range of machines, from the 9370 to the 3090. CBDS is also available on the RT/PC personal computer, under the AIX operating system. EA

CAD Feature:

New CAD products

Micro CADAM enhanced

CADAM Inc. has enhanced the functionality of its PC-based CAD system with the release of Micro CADAM Cornerstone 1.3.

The new features supported by Release 1.3 include:

1. Network support, enabling users to share, send and receive design data over a wide variety of DOS and UNIX based LANs.
2. Extended support for input and output devices.
3. Automated installation.
4. Automatic creation of multiple chained offsets, that creates multiple parallel offsets from complex geometric figures.
5. An optional geometry interface module (GIM) that allows programmers to create FORTRAN application programs.
6. An optional function key box that facilitates the function selection process.

Geometry libraries for mechanical, electrical and architectural design are now also available as options.

Micro CADAM products are available in Australia from the distributor, Anthony Borg & Associates, on (03) 584 5905. In New Zealand, contact Geometric Modelling Services on (09) 39 1402.

New release for AutoCAD

Autodesk Australia has announced a number of enhancements for its widely used AutoCAD system for personal computers, in the latest Release 10.

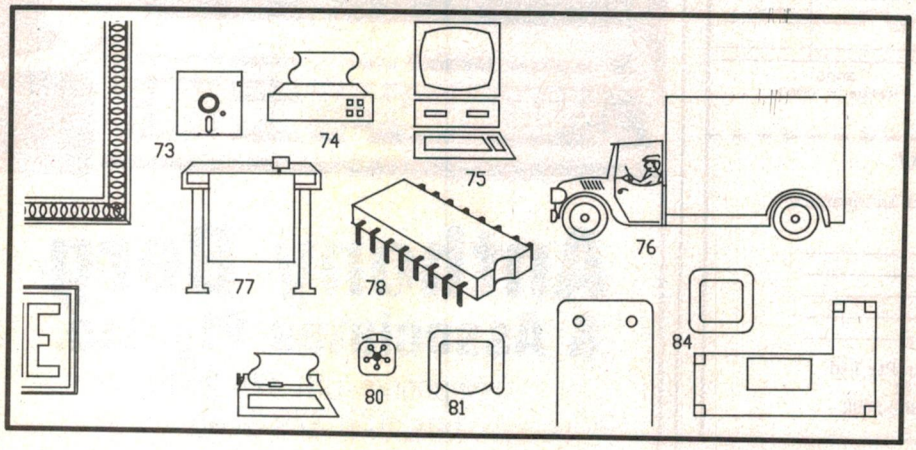
AutoCAD now features 3-D wireframe construction and surface modelling capabilities, together with new drawing, viewing and database features. Also for the first time, this version of the package is available for use on Apple's Macintosh II.

Surface modelling features of Release 10 include 3-D meshes or surface patches, surfaces of revolution, tabulated cylinders and ruled surfaces defined by two boundary curves. Dynamic viewing allows the user to rotate the 3-D model in real time to any orientation. 3-D designs can also be viewed in parallel or perspective projection.

A new multiple viewport feature lets the user display 3-D models in up to four viewports on 16-bit systems and up to 16 viewports with 32-bit systems. Any viewport can be made active, and all changes are automatically updated in all corresponding viewports.

Further details are available from Autodesk Australia, 9 Clifton Street, Richmond 3121 or phone (03) 429 9888.

AutoSketch symbol libraries



Edutech Production has produced three new symbol libraries for AutoSketch, designed with the same professional care as the company's existing libraries for AutoCAD.

The three libraries are devoted to Clip Art, Electrical & Electronic, and Hydraulic and Pneumatic symbols respectively. The Clip Art symbols are capable of being extracted and uploaded into desktop publishing packages (file.SLD format only).

Each library comes on two 360K IBM formatted 5.25" floppy disks, and costs $55 plus sales tax.

Further details from Edutech Productions, PO Box 139, Ringwood East, 3135 or phone (03) 720 2488.

ESP is a very intelligent digital and analog circuit design schematic capture tool, which runs on IBM PC/AT and compatible computers, Digital Equipment VAX systems and Whitechapel workstations.

ESP incorporates a set of interfaces to the more popular simulators and routers. It uses a mouse or puck for data entry and offers full colour and zoom capabilities.

Key features include unlimited levels of hierarchy, automatic symbol status checking and replacement, automatic text location and labelling, and the ability to handle multi-sheet schematics up to A00 size.

Cost of the package is $8500 and it can be evaluated prior to purchase.

Further details from Parameters, 25-27 Paul Street North, North Ryde 2113 or phone (02) 888 8777.

Fast redraw for AutoCAD

A new software driver which can redraw an AutoCAD image instantly after pan and zoom has been introduced by Verticom, for its range of colour graphics monitors, distributed in Australia by Sourceware.

The new driver, called Twinfocus, will also enable AutoCAD users to view two sections, or windows, of an AutoCAD drawing simultaneously, and to draw lines between them.

Sourceware is offering Twinfocus as an option for Verticom's H Series graphics controller cards.

Twinfocus can 'remember' the original AutoCAD drawing before pan or zoom takes place, and return to it instantly once either is complete.

Further details from Sourceware, 586 Pacific Highway, Chatswood 2067, or phone (02) 411 5711.

New PCB, schematic design programs from Protel

Building upon its existing highly successful Australian developed PCB design package, Protel Technology has produced a new generation package called Protel-Autotax. This provides many new and enhanced features such as auto component placement and track routing, interactive routing and placement, and the ability to support either through-hole or SMD devices with user-selectable design rule clearances.

Hardware requirements are an IBM PC/XT/AT/PS2 with 640K RAM, two floppy disk drives or one drive and hard disk, and PCDOS or MSDOS later than V2.0. Copy protection connects to the LPT1 or LPT2 printer ports.

Protel-Autotrax supports CGA, EGA, VGA, VGA deluxe and Hercules graphics cards. Maximum board size is 813 x 813mm (32″ square). It can handle PCBs with up to six signal layers plus power and ground planes, two component overlays, two solder masks, two paste marks and one keep out. Visual or snap grids with 1 to 1000 mils resolution are available, with absolute or relative zero points. Tracks and vias are user definable from 1 to 255 mils.

Protel-Schematic Version 3.0 is the latest version of this low-cost high performance program for creating schematic diagrams of digital and analog circuits. It can be used as a stand-alone package, or in conjunction with Protel-PCB to form part of a powerful PCB design system.

The program now incorporates full pull-down menu operation or can be command driven with optional keyboard macros. Hardware requirements are basically as for Protel-Autotrax, with the same copy protection system.

Protel-Schematic is supplied with more than 3000 components in its libraries, with a graphics editor (SLM) to either change existing component symbols or create new ones. A special feature of the program is its text creation ability. Text may be placed with components or freely on a drawing by invoking a word processing function.

Further details are available from Protel Technology, Technopark, Dowsings Point, Glenorchy 7010 or phone (002) 73 0100.

3-D design on a PC

CADKEY 3 is claimed to allow the most sophisticated features of 3-D mainframe design to be performed simply on personal computers, at a fraction of the cost.

Cost of CADKEY is $5500 plus tax, and it will run on hardware costing under $5000. Minimum requirement is an IBM PC or compatible with 640K of RAM, hard disk, graphics board and screen and a floppy disk drive to load the program. A 286- or 386-based machine with co-processor, EGA and mouse is recommended.

CADKEY produces a 3-D geometric model which acts as an accurate prototype. This can be viewed from any angle and dimensioned according to ANSI or ISO drafting standards. Once a part is created on screen it is managed as a single 3-D model with x, y and z coordinates to seven digits of accuracy. This allows the generation of an unlimited number of views from the 3-D model.

A 'solids synthesis' function automatically produces a 'solid' model from 3-D wire frame geometry and graphically depicts it as a true shaded solid. Up to 356 colours can be plotted at one time.

Further details are available from Advanced Manufacturing Technologies, 31-33 Parramatta Road, Lidcombe 2141 or phone (02) 648 3477.

CAD Product Review:

Economy CAD package for PC's

CCS Designer is a relatively new CAD package for use on IBM PC's and compatibles. It offers many features often found only on quite expensive packages, yet is currently on offer complete with a mouse for only $299!

There are now quite a few different CAD software packages available to run on the almost ubiquitous IBM PC's and compatibles – with capabilities varying widely. You can go all the way from fairly simple computer-aided drafting and sketching, through 3-D solid modelling, to full-scale circuit capture/analysis/simulation/auto-routing of the PCB pattern and so on.

Not surprisingly the prices tend to cover a similarly wide range: from a few hundred dollars up to over $20,000. That's right, just for the software!

Most of the packages down at the bottom end of the price range are fairly spartan, offering very few of the features available on those further up market. But a recent addition to the low end attracted our attention, because it does seem to offer rather more than the others – and at a very impressive price. As noted above it sells for only $299, complete with operating manual and a mouse. Some mice alone sell for more than this!

The package is called *CCS Designer*, and it comes from a company in California called Complete Computer Services Inc. It's being distributed in Australia by Electronic Solutions.

CCS Designer runs on virtually all normal IBM PC models and compatibles, as long as they have at least 512K bytes of RAM. It can be set up to run on most graphics cards, including the Hercules mono, CGA, EGA and PGA, and also supports a wide range of mice, digitising tablets, printers and plotters. Laser printers are supported as well as a range of dot-matrix types.

By the way, CCS Designer will work quite happily from a normal or extended PC keyboard. A mouse isn't essential, although it's a little more convenient. Various keys are used to call up the program's range of functions, most of which involve only one keystroke apart from identifying various points.

The features it offers are quite impressive, particularly for a package in this price bracket. For example it will draw 'rubber band' lines and boxes; zoom up and down over a wide range of magnifications; rotate a drawing through any desired angle (2-D); allow section move, copying and mirroring; automatically dimension and scale a drawing; draw arcs and parts of ellipses; draw multiple-segment lines in a single operation; 'fill in' any desired area with a few simple keystrokes; and draw in up to 16 colours (dependant mainly on your computer's graphics card and monitor).

As well as setting a point using the current cursor position, you can define it in terms of either Cartesian (X-Y) or polar co-ordinates, from the last point set.

Drawing things like circles are very easy. You simply define the circle's centre point, then one point on its periphery, and press the 'Draw Circle' key. If you define a third point before hitting the function key, it will draw an ellipse instead of a circle.

Similarly rectangular boxes are drawn simply by defining two diagonal corner points, and then pressing the 'Draw Box' key. The 'Rubber Band Box' function may be used to visualise the box dynamically, as you move the cursor, and before drawing it in permanently. Virtually the same approach is used for straight or curved lines, with the 'Rubber Band Line' function used to visualise progress.

Sections of a drawing can be saved on disk separately, to become often-used symbols. Alternatively you can draw new symbols separately at a size much larger than they'd be used, to get the best detail, then zoom them down to working size and save them at that size for later use.

Sections of a drawing can also be moved or copied, simply by defining the area concerned and then identifying where you want it to be moved or copied. For repeated moves or duplications there's also a 'Repeat Move or Copy' key, which is quite convenient.

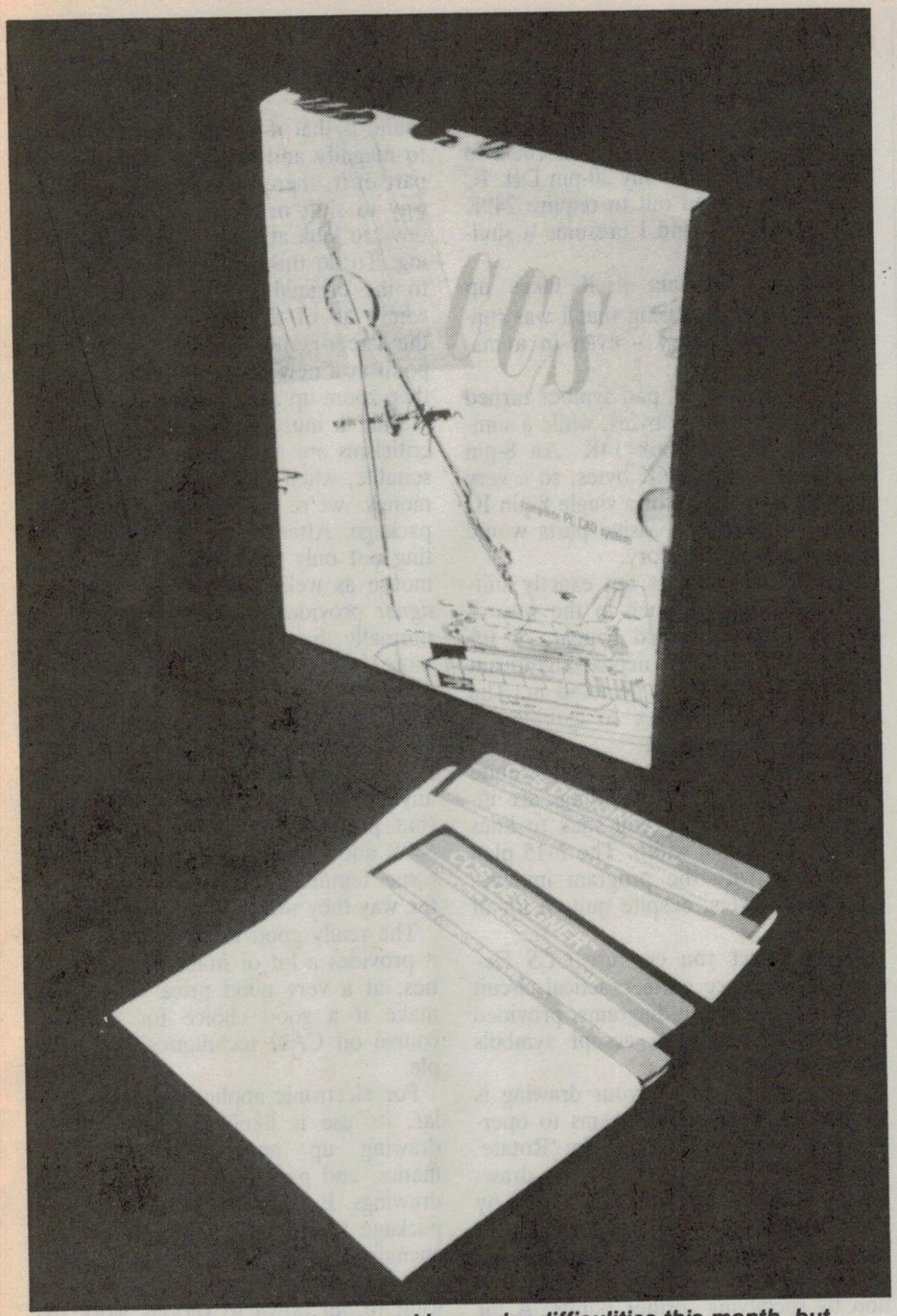
Other interesting features of *CCS Designer* are its provision of three different types of working grid (full grid, border graduations, or dot array), or no grid; optional cursor 'cross hair' lines to allow more convenient alignment; range of line widths and types; and choice of two different text fonts for labelling and titling.

There's also a handy 'help' facility, which lists on the screen all of the available commands whenever you hit the '?' key.

A particularly nice feature is the so-called *Gravity Point* function. This lets you zero the cursor in on the nearest point of your drawing, just by pressing the full-stop key.

The idea behind this is that when drawings are zoomed, rotated, or sections saved and then retrieved, they can end up with various points not exactly lined up with the screen's grid. This can make things tricky, because the cursor normally moves in step increments aligned with the screen grid. So without the gravity point function, it can be impossible to place the cursor on a particular part of the drawing.

What the gravity point function seems to do is shift the reference for cursor in-



Our photographers have been working under difficulities this month, but here's roughly what the package looks like without the mouse.

crementing, so that one of the cursor comes into exact alignment with the nearest point of the drawing. Very nifty!

There's also a similar *Gravity Move* feature which allows you to move symbols retrieved from disk, so that they mate exactly with existing sections of a drawing.

Parts of a drawing can be erased in a number of ways. If you've only just drawn a line or shape, you can erase it again using the 'Undo last drawing command' function key. Alternatively you can use the 'Erase' function, after identifying key points on the line or shape to be deleted. A third option is to use the 'Section Delete', after defining the borders of the area you want to erase.

If you make a mistake when erasing/deleting, there's also an 'Oops' key to undo the last erasure.

Trying it out

So much for CCS Designer's features and functions. But how does it work out in practice?

Some CAD packages take a lot of time to get into them, before you're really able to do much at all. Basically I found *CCS Designer* quite good in this respect; after a couple of hours playing around and studying the manual, I was able to do most basic operations quite easily.

One of the things I discovered fairly early on was that the basic CCS package doesn't come with any existing symbol library. There's just a line drawing of the plan for an F-15 fighter plane, to give you an idea of the package's capabilities.

A symbol library disk is available separately, if you want it. This provides symbols for plumbing, electrical and electronic applications. But the library disk wasn't available at the time of reviewing the package, so it was necessary to try creating my own using the basic package.

This turned out to be relatively easy, and it had the additional benefit of letting me discover more about the package's features – as well as a few of its limitations.

The manual suggests creating your symbols as large as possible on the screen, and then zooming them down for storage and later use. I tried this, finding out along the way that if you used different line widths to create your symbol, these seem to remain at their original widths when you zoom down. So my nicely proportioned bipolar transistor symbol turned into a solid filled-in circle, when I reduced it to working size!

In other words, it seems to be desirable to create your symbols using the basic unit-width lines, so they're still readable when you reduce them.

Another thing I discovered before long was that if you used the 'Paint' function to fill in areas of your drawing/symbol, you soon run out of memory.

For example I first created the symbol for an IC pin pad, for a PCB. Then I saved it, and retrieved it eight times to create the pattern for an 8-pin DIL package. Then after saving this in turn, I added more of the pad symbols to create patterns for a 14-pin package, a 16-pin package and so on – saving each one as I went along.

By the time I had created a 20-pin DIL pattern, the program flashed up a warning: 'Image too big – must save'. So I saved it immediately, but found when I retrieved it that it had been corrupted anyway.

Other experiments along the same lines showed that filling in areas of your drawing or symbol dramatically expands

Economy CAD package for PC's

the amount of memory area needed, and also the disk file size needed to store it. For example my 20-pin DIL IC pad pattern turned out to require 249K bytes of storage, and I presume a similar memory area.

Since the program itself takes up 135K, it's not surprising that I was running out of memory – even in a machine with 640K.

Even the basic IC pad symbol turned out to require 13.3K bytes, while a similar donut symbol took 14K. An 8-pin DIL pattern took 106K bytes, so a very simple PCB pattern for a single 8-pin IC and a dozen or so passive parts would probably fill the memory.

So *CCS Designer* is not exactly suitable for designing much in the way of PCB patterns, it would appear, or for anything else that needs significant areas of a drawing to be filled in. The filling in really seems to gobble up memory and disk space.

On the other hand it does seem quite economical where line drawings are involved – especially if you stick to lines in the basic single width. The F-15 plan that comes with the program involves only 13.6K bytes, despite quite a lot of linework.

So I suspect you can use *CCS Designer* to produce quite practical circuit schematics and logic diagrams, provided that you're happy to accept symbols with unit-weight lines.

The ability to rotate your drawing is good, and this function seems to operate quite quickly. Note that the 'Rotate' function operates on the complete drawing, as a whole. To rotate a section by itself (to orientate a symbol, for example), you need to move it to the same location, specifying a new angular position by specifying further points. A bit messy, but it can be done. So for circuit schematics you'll probably want to define separate symbols for each component in various orientations: vertical, horizontal, upside down and so on.

Actually it turns out to be a little tricky to move existing screen symbols to a new location, or to position those retrieved from disk, because *CCS Designer* uses the bottom left-hand corner of each symbol as its datum. This complicates matters for electronic circuit schematics, for example, because in most cases you want to position a symbol to line some other part of it up with the existing drawing.

The only other little shortcoming I found is that if you zoom up a drawing to magnify and fill the screen with one part of it, there doesn't seem to be any way to shift or 'pan' your screen 'window' to look at other parts of the drawing. To do this you have to zoom back to the original size (or at least a size where all of the drawing is visible on the screen), move the cursor and set a point at a new part of the drawing, and then zoom up again.

Still, I must point out all of these criticisms are really being rather unreasonable, when you consider the kind of money we're talking about for this package. After all, for $299 you're getting not only the basic package, but a mouse as well. It's just that *CCS Designer* provides so many of the features normally found on much larger and more fancy packages, that it's hard to avoid judging it by the same standards!

All in all, it's really a very nice little CAD package indeed. In fact it would make an excellent starter package, for anyone with a PC compatible machine (but preferably an AT-level one, with 640K and a hard disk) who wants to become familiar with CAD systems and the way they work.

The really good thing about it is that it provides a lot of functions and facilities, at a very good price. This would make it a good choice for a college course on CAD techniques, for example.

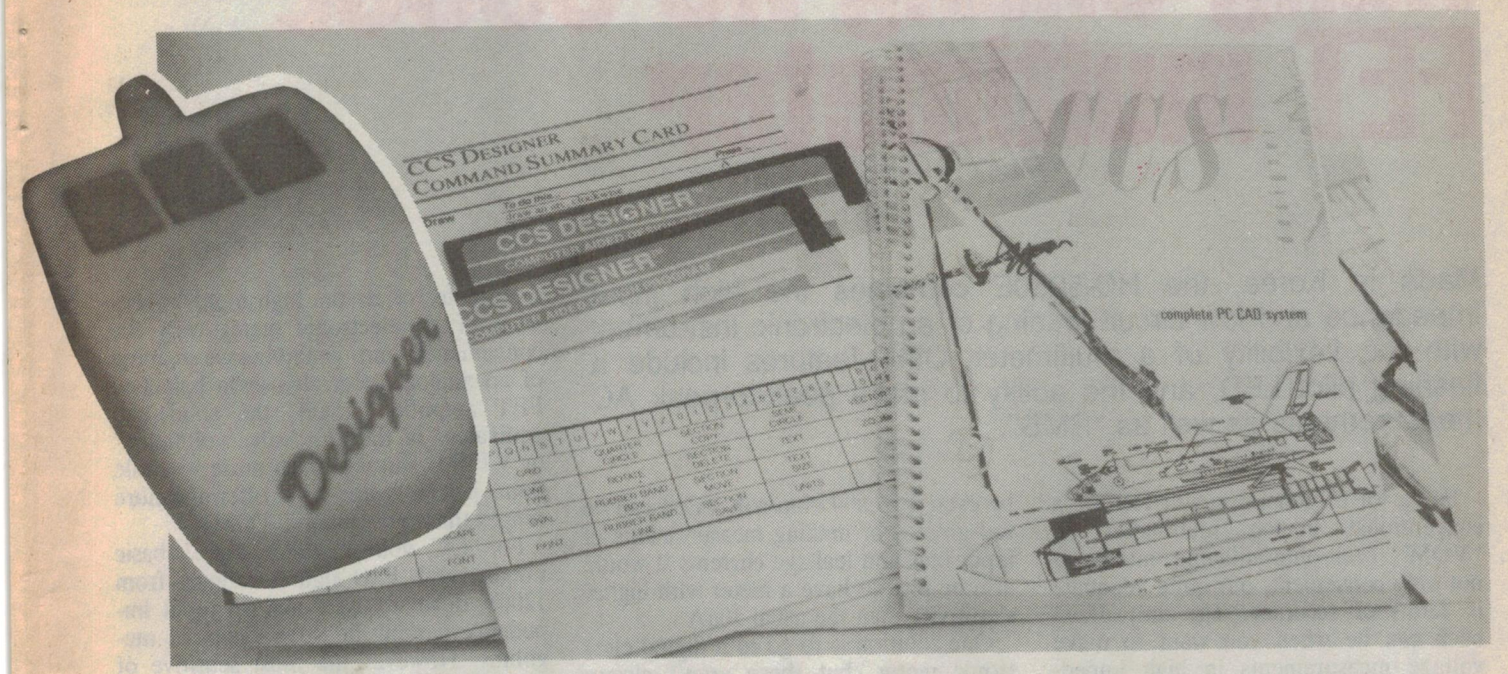
For electronic applications in particular, its use is likely to be limited to drawing up not-too-elaborate schematics, and perhaps making metalwork drawings. But again it would be a good package to cut your teeth on, perhaps changing over to one of the more elaborate (and expensive) packages when you want to get down to serious work like PCB design.

As already noted, the basic *CCS Designer* package sells for $299 (RRP), complete with manual and a Dexxa mouse (very similar to the Logitech). Incidentally the basic package comes with two versions of the program, one for computers with the 8087 maths co-processor chip, and other for those without. An installation/setup program is also included.

The optional Symbols Library disk costs a further $79, again RRP.

CCS Designer is available from Electronic Solutions, of PO Box 426, Gladesville 2111 or phone (02) 427 4422. (J.R.)

Complete CAD Package
. . . for just the cost of a mouse



Now you can create detailed, professional quality designs and drawings quickly, easily and inexpensively.

CCS Designer comes with many of the same powerful features found in CAD systems costing hundreds, even thousands, of dollars more. All you need is an IBM PC/XT/AT or compatible computer with 512K RAM and you'll be creating designs in less than 30 minutes.

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Product review:

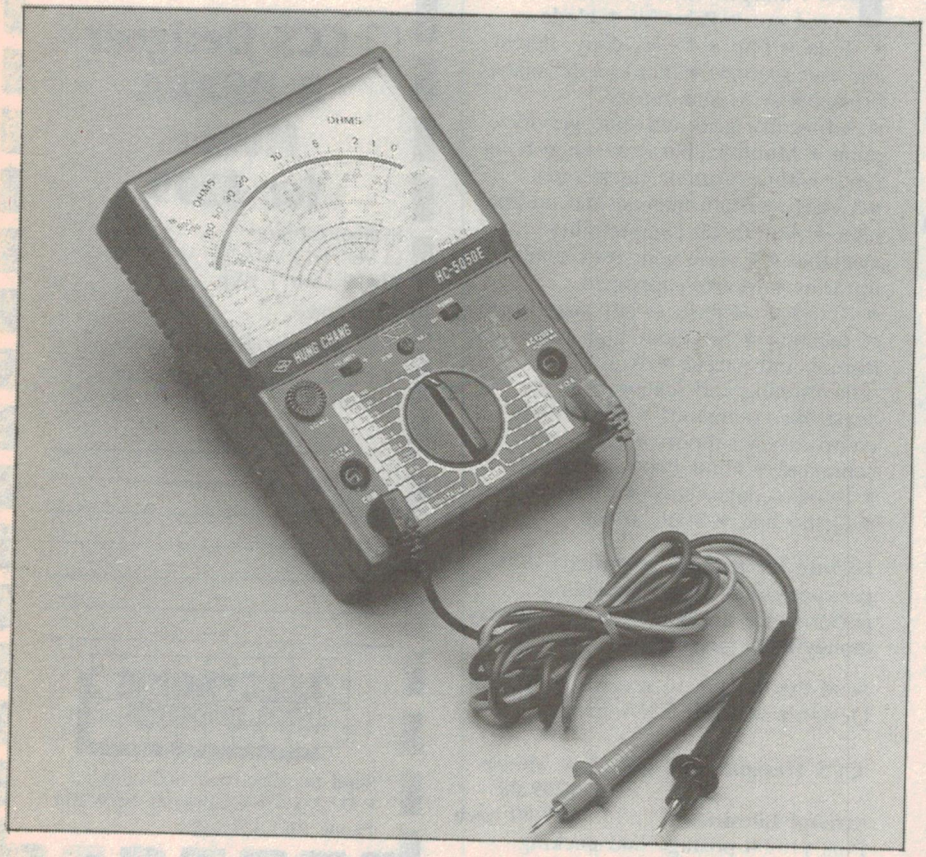
Hung Chang HC-5050E FET multimeter

Made in Korea, the HC-5050E combines the high input impedance and low circuit loading of an electronic instrument with the flexibility of a multimeter. Other features include a flashing pilot LED, and the ability to make peak-to-peak AC measurements as well as "RMS".

For a lot of general circuit testing, a conventional analog multimeter or "VOM" (volt-ohm-milliamp meter) is not only convenient, but quite adequate in terms of accuracy. The only drawback can be when you want to make voltage measurements in high impedance analog circuitry operating from low voltages, where the loading introduced by even a 20,000 ohm/volt VOM can be too great. For making measurements of input bias and leakage currents it would also be nice to have a meter with higher sensitivity than the usual 50uA.

One solution is to go to a digital electronic meter, but these aren't always the most suitable.

The Hung Chang 5050E electronic multimeter offers the high input impedance of an electronic meter with the convenience and unambiguous reading of an analog meter. It uses a balanced FET amplifier circuit, the solid-state equivalent of the old "valve voltmeter" or VTVM. But it's much more versatile than just a voltmeter, offering more ranges than most passive VOMs.



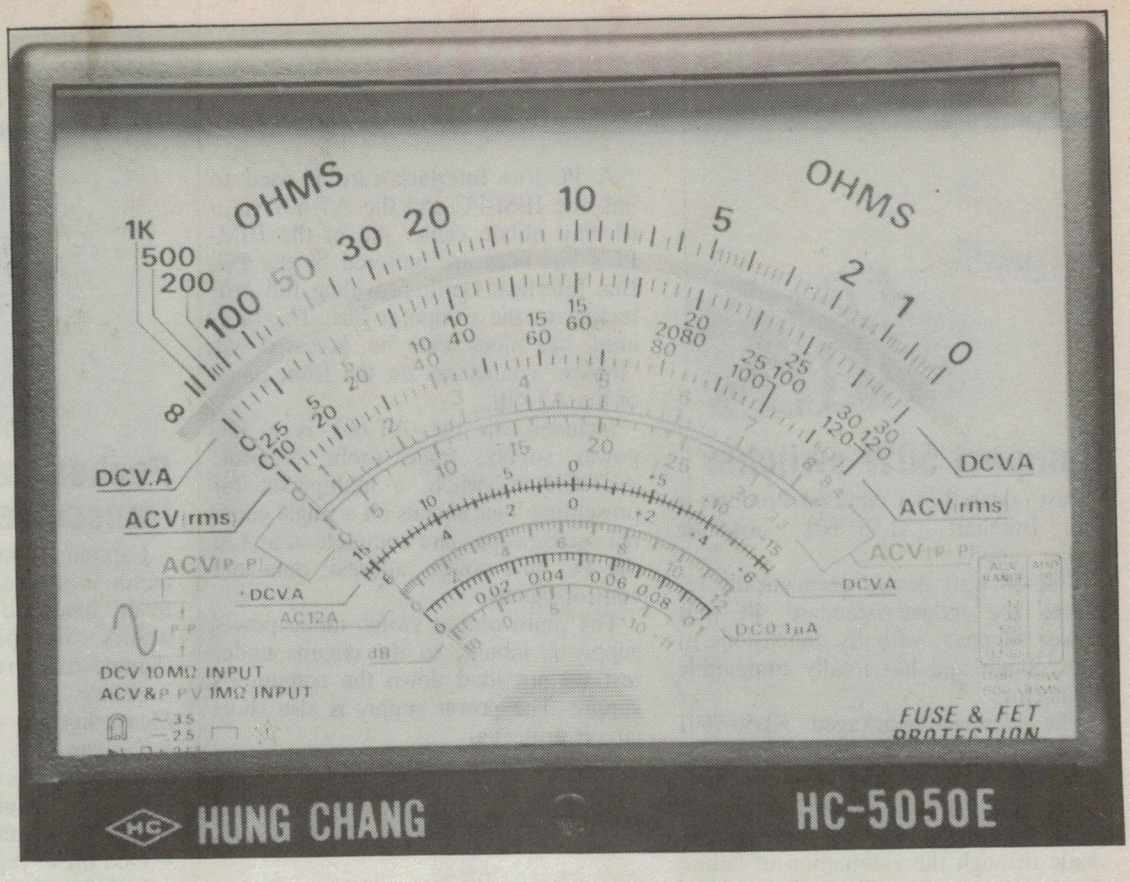
For DC voltage there are 7 basic ranges, with FSD figures ranging from 1200V down to 1.2V and an input impedance varying between 9 and 11 megohms. However the most sensitive of the DC current ranges can also be used as an even more sensitive voltage range, with an FSD of 300mV and an input impedance of 3M – quite handy.

The same range can be used as an extremely sensitive current range, with an FSD of 0.1uA. Yes, that's right, 100 picoamps! It's virtually an electronic galvanometer.

The 5 other DC current ranges have more conventional FSD figures varying from 300uA to 300mA in decade steps, and finally 12A.

As an added feature all of the DC voltage and current ranges have the ability to shift the zero up to mid-scale on the meter, to convert them into centre-zero ranges such as +/-6V, +/-150uA and so on. Very flexible, and something you can't do on a passive VOM of course.

There are 6 AC voltage ranges. As the FET amplifier circuit has a very high impedance, the diode detector circuit used for the AC voltage ranges is essentially responding to the peak-to-peak value of the AC, just like the old VTVMs. However for added flexibility the 5050E meter is provided with scales calibrated in terms of both P-P and RMS (assuming a sinewave). So in terms of RMS the six ranges have FSD figures of 3, 12, 30, 120, 300 and 1200V, while for P-P readings they cor-



A close-up of the meter face, a little larger than actual size. Note the provision of both RMS and P-P scales for AC, and the 0-100pA scale second from the bottom.

respond to 8.4, 33, 84, 330, 840 and 3300V.

For AC current there is just one range, calibrated separately as 0-12A RMS because of rectifier non-linearity.

The 12A ranges for both DC and AC use a separate input jack, as does the 1200/3300V highest AC voltage range. All of the remaining ranges use the two main input jacks, for convenience. There's also a polarity reversing switch for DC voltage and current measurements, to avoid the need for lead swapping.

Incidentally the input jacks are all recessed to prevent accidental contact, and designed to take guarded banana plugs as fitted to the test leads supplied. The instrument therefore complies with UL1244 and VDE 0411 safety requirements.

For resistance measurement there are 6 ranges, with centre-scale values of 10Ω, 100Ω, 1k, 10k, 100k and 10M respectively. Like the resistance ranges on a conventional analog multimeter, these have zero ohms at full scale and "infinity" at the bottom. However unlike most multimeters and like the old VTVMs, the "+" test lead does indeed become the more positive of the two for resistance measurements. Something you need to remember when checking things like diodes!

From a practical point of view the effective overall range of the resistance ranges is from about 1Ω up to about 100M, with a rough indication down to 0.1Ω and up to 1000M. Quite good for this kind of instrument.

The meter movement fitted to the 5050E is a 133mm (4-1/2") moving coil type with a 90° scale arc. It has a fine knife-edge pointer and mirror-backed scale, for accurate reading. As shown in the pictures it is provided with more than the usual number of scales, but colour coding helps to cut down the clutter to at least some extent. The lowest and least readable scale is for dB measurements, and is probably not going to be of much practical use.

Protection for the dual-FET measuring circuit and meter movement is provided by a further pair of separate FETs, connected as diodes, plus an internal fuse.

The other main point to note about the 5050E is that it has a flashing LED pilot, to remind you when the power is turned on. Power for the basic instrument comes from a 216-type 9V battery, with a pair of AA-size cells used for the ohms ranges source. Average current drain from the main battery is less than 3mA.

On test, the sample unit pictured performed quite creditably. The accuracy for DC measurements was within the quoted +/- 2.5% of FSD, and for AC it was within the quoted +/- 3.5% of FSD. The ohms ranges also seemed to be within the +/-2.8% quoted, for all values we were able to try.

Drift appeared to be very low indeed, with a needle movement of less than its width over a 1 hour period from switch on, even on the 1.2V and 300mV/100pA ranges.

In fact there were only three criticisms we could make about the sample meter – all relatively minor and fixable.

One was that its movement did not appear to have been well balanced mechanically, so that the zero would vary for various orientations of the meter. Another was that the ohms adjust pot appeared to be noisy, making it a little difficult to set it for zero ohms (especially on the lower ranges). And the third was that the frontmost of the three internal pillars which receive the back-cover mounting screws had broken off – suggesting that the plastic moulding may not be strong enough.

Otherwise, it seems a very practical little instrument, and good value for money at the quoted price of $79.95.

The review unit came from Wagner Electronics, of 305 Liverpool Road, Ashfield 2131 or phone (02) 798 9233. (J.R.)

New Products

Compact 50W switcher

Just released by Computer Products is the Boschert XL50-7601 switching power supply.

This 50 watt device mechanically replaces the industry-standard 40 watt power supplies, with its dimensions of 100x160mm and has totally compatible connectors.

The compactly-packaged XL50-7601 has a continuous input of 85 to 264 VAC which does away with the need for an external 115/220 VAC switch and cable assembly. Further savings are made through the elimination of failure due to improper input voltage. And since the device is suitable for world-wide application, only one type of power supply need be purchased and stocked.

The XL50-7601 has a minimum switching frequency of 20kHz, is protected against overvoltage and output short-circuit and has a hold-up time of 16msec.

Further information from Amtex Electronics 13 Avon Road North Ryde, NSW 2113 or (02) 805 0844.

PC Interface design tool

The A-Tek AT-601 is a unique product specifically designed to enable IBM-PC interfaces to be easily designed, evaluated, tested and modified. The breadboard (3060 tie points) is large enough for the complex prototyping that is often necessary in such applications.

A PC-Bus Interface card is used to link the IBM-PC and the AT-601 via a 64 way ribbon cable. All of the IBM-PC's bus lines are buffered by the PC-Bus Interface Card, providing full protection to the computer bus. The buffered bus lines can be accessed via "molex" connectors on the front panel of the AT-601.

Included on the AT-601 is a DC power supply, logic probe adaptor, ALT/CHOP switch, a multiplexer for presenting logic signals on a single channel oscilloscope, and complete access to the PC bus, power, address, data and control signals.

The multi output switch mode power supply is inbuilt, so the circuits under test do not load down the computer's supply. The power supply is also short circuit protected.

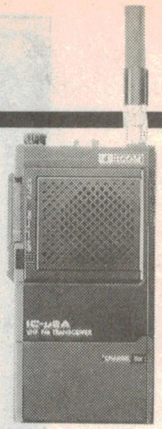
Further information from Emona Instruments, 86 Parramatta Road, Camperdown 2050 or (02) 519 3933.

Plastic dip coating

PDI Plasti Dip is an air-dry liquid plastic dip coating which produces a tough, thick pliable finish for the handles of tools, etc.

The resulting coating is red in colour, virtually impervious to the elements and has good dielectric strength. Multiple coats can be used for increased thickness and protection. Drying time per coat is 4 hours at 70°F.

Jaycar Electronics has Plasti Dip in 473ml (16 fl.oz) cans, for $24.95. Further details from all Jaycar Electronics sales outlets, or from 115-117 Parramatta Road, Concord 2137 or (02) 747 2022.



Pocket sized 2m transceiver

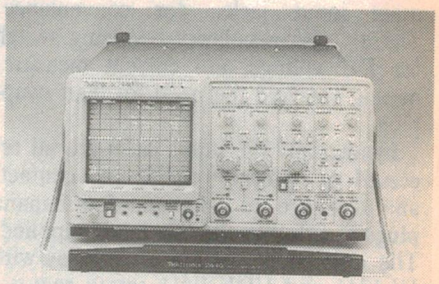
Captain Communications of Parramatta is now stocking the micro-sized Icom handheld series – the ICOM u2A/A. The palm-sized transceiver is claimed to represent a breakthrough in 2 metre "go anywhere" technology. Measuring just 4.6″ high, 2.3″ wide and 1.1″ deep, the IC-u2A/A packs more features than some large transceivers.

Features include:

- 10 programmable memories
- Odd offset capability
- LCD readout
- 2.6 watt output
- 32 built-in subaudible tones

In ICOM tradition, the IC-u2A/A has an extensive range of accessories, including rechargeable batteries, carry cases, headsets, and even a vox.

For further information call or fax the Captain: Phone (02) 633 4333, fax (02) 891 2271.



300 MHz digital sampling scope

The new Tektronix 300MHz 2440 Digital Oscilloscope combines 8-bit vertical resolution with 500 megasample per second, dual-channel, simultaneous acquistion – the highest sampling rate available in a portable scope. the 2440's combination of high resolution and sampling rate gives users noticeably more horizontal and vertical waveform detail. The result is improved ability to accu-

rately capture very fast single-shot events.

The high performance 2440 offers all the popular built-in automation features pioneered by other 2400 Digital Oscilloscopes – all in a GPIB-compatible unit compact enough to serve as either a system component or standalone test station.

Even unknown signals can be captured and displayed on the 2440 with the push of a single button. This feature automates and simplifies setups for measurements such as rising edge, falling edge, pulse width and period. In addition to the 2440's familiar front-panel controls, set-up and measurement functions can be initiated by an ID button on the head of Tektronix's new P6137 350MHz passive voltage probe.

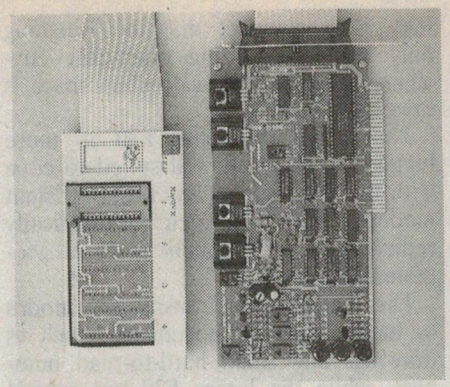
Further information from Tektronix Australia, 80 Waterloo Road, North Ryde 2113 or (02) 888 7066.

EMI suppression inductors

Pulse Engineering has developed a complete inductor family to provide a package with guaranteed minimum resonant frequency and leakage inductance limits. These are important parameters to consider when designing on-board filters for high frequency switch-mode power supplies. The wide variety of available component values makes it possible to design a board mounted filter with optimum performance characteristics.

The Inductor Kit has a selection of 31 inductors with rated currents from 1 to 15 amps. All are tested to VDE 0565 part 2 and UL 1278. Dielectric tests are 3750 VAC (winding to winding).

Complete details of the kit are available from Clarke & Severn Electronics, PO Box 129 St Leonards NSW 2065 or (02) 437 4199.



EPROM burner for PC's

Electronics Solutions has released a powerful EPROM burner with superb "drop down" menu software. Extensive help facilities make EPROM work a snack with the ES Burner. It is suitable for burning most popular EPROMs and comes with a high quality ZIF socket and cabling, with facility to add 3 more sockets if necessary.

Facilities include the ability to read, write, copy, compare and erase the contents of EPROMs. It can also verify data and even combine the data in two smaller EPROMs into a larger one. It is compatible with 2716, 2732, 2764, 27128, 27256, 2804, 2816, 2864, and 58064 devices.

The EPROM burner comes complete with software and user manual. Price is only $195 including tax and it comes complete with a 14 day money back guarantee.

For further information contact Electronic Solutions, PO Box 426 Gladesville 2111 or (02) 427 4422.

Fax is OMR-card programmable

The new Toshiba TF-211 facsimile is specifically designed for small to medium sized offices. It is claimed to be particularly "user friendly", with the option to use Optical Mark Reader Cards (OMR) which will automatically access virtually any function of the machine.

for example, when an executive wants to send documents overseas at a specific time – which because of the time difference, happens to be in the early hours of the morning in Australia – an OMR card can be easily written to perform the task. It dials the number and transmits the information. Even multiple transmissions can be made after hours.

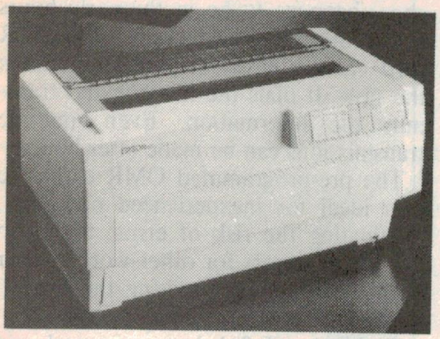
The pre-programmed OMR cards are also ideal for inexperienced operators, eliminating the risk of error; they also release operators for other work, rather than have them supervising the facsimile's operation.

Toshiba's TF-211 has an optical and printing system which will send, and reproduce, up to 16 shades of grey ranging from the softest to the darkest tone. A further benefit is a contrast adjustment which can be fine tuned.

The TF-211 uses internationally recognised G2 and G3 modes for transmission and reception, plus a high-speed mode for communication with other Toshiba models. Voice communication, internal copying of documents and a logical grouping of operating instruction complete the TF-211 lineup.

For further information call Jonathan McQuade, National Sales Manager – Facsimile, Toshiba Copier & Facsimile Division, on (02) 887 6034.

New Products



533cps line printer

Epson Australia has released the DFX-5000, a high speed, heavy duty printer that has been specifically designed for long print runs in the DP/MIS and office environment.

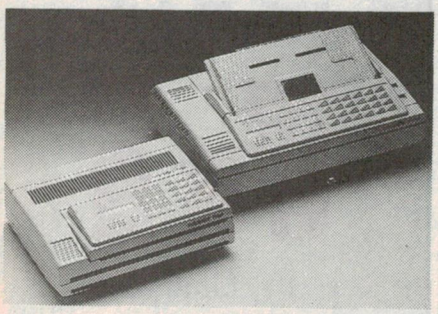
Filling the gap between high cost line printers and traditional impact dot matrix printers, the DFX-5000 is ideally suited for printing invoices, statements, labels, stock control and continuous report generation where speed and continuous use are of paramount importance.

It prints at 533cps in high speed draft mode, and the long life print head is capable of printing up to 200 million characters.

A dual tractor "Smart Park" function allows the user to switch instantly between two types of continuous paper from the front panel. It prints multi-part stationery up to 6 sheets.

The DFX-5000 can be connected to mini and mainframe computers as an ASCII printer. Optional TWinax and Coax interfaces, which support IBM System 34/36/38 and IBM 3270 respectively, will be also available soon from Epson.

For further information contact Epson sales offices in Sydney on (02) 436 0333 or Melbourne on (03) 543 6455.



Portable fax models

Voca Communications has released the new portable Voca-fax F20 and F30 facsimile machines.

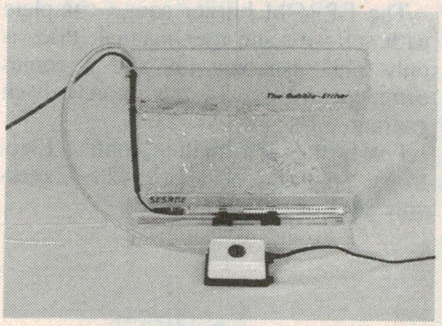
The smaller of the two, the Voca-fax F20, is a compact machine weighing only 4.2 kilos, fitting practically anywhere, even on the wall when space is extremely limited.

The larger Voca-fax F30 is more highly featured and well suited to cope with the demands of any busy, efficient modern office. It even automatically redials engaged numbers twice at programmed intervals.

The F20 has two transmission modes to handle detailed documents, such as drawings and small hard-to-read numbers, while the larger F30 has several transmission modes and can accurately reproduce photographs through its 16 shade greyscale transmission facility.

The F20 and F30 can handle paper up to over 25cm and 28cm wide respectively, automatically reducing documents to the printing capabilities of the receiving unit. The two new models even have a polling feature allowing document retrieval from a remote fax machine. Furthermore, if security or limited access is a high priority, a four-digit passcode can be used to prevent unauthorized polling of sensitive documents.

For further information, contact Voca Communications, 11-29 Eastern Road South Melbourne 3205 or (03) 697 7000.



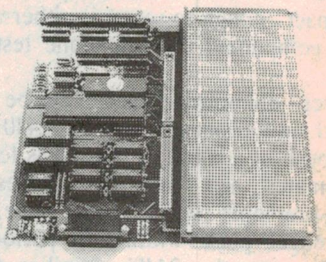
PCB bubble etcher has heater

Sesame Electronics has added a heater to its PCB Bubble Etcher. Instead of throwing the etchant away after it cools down, you can heat it up again and etch more printed circuit boards.

The Bubble Etcher is a clear acrylic tank, holding the etchant in a narrow, vertical slot. Bubbles are pumped into it by an air pump, and the movement of the fluid plus oxygenation rinses away the dissolved copper, etching the board clean in a few minutes without any stirring.

Using ammonium persulphate allows the progress of the etching to be seen, as it is a clear solution, reducing the risk of over-etching, and consequent undercutting. The Etcher will handle boards up to 12"x10" (305 x 254mm).

For more information contact Sesame Electronics, PO Box 452, Prahran, 3181 or (03) 527 8807.



68000 Single board computer

The Interrupt Systems 68000 Single Board Computer is a high performance computer system core based on the Motorola 68000 16/32 bit processor. With up to 128K bytes of on-board DRAM, RS232 communications, 68000 buss access and a reusable prototyping area, this computer is intended for a wide range of real-time design applications.

Use is made of ALTERA and ACMOS logic resulting in a very cost-effective system. The 68000 core can be readily accessed from the general purpose prototyping area, thus allowing quick development of the required application. A range of bus signals and additional lines such as pre-decoded chip selects with DTACK implementation are available to suit most prototype designs.

The board is equipped with 128K bytes of 41464 DRAM and 64K bytes of 27256 EPROM. The 68000 processor runs at 12.5MHz and utilises an MC68901 Multi-Function Peripheral Controller providing one RS232 serial port, four timer counters and a general purpose 8 bit I/O Interrupt Controller.

Designed and manufactured in Australia, local hardware and software support is readily available. Software provided includes a monitor/debugger and system software in EPROM. A range of high level compilers is available separately.

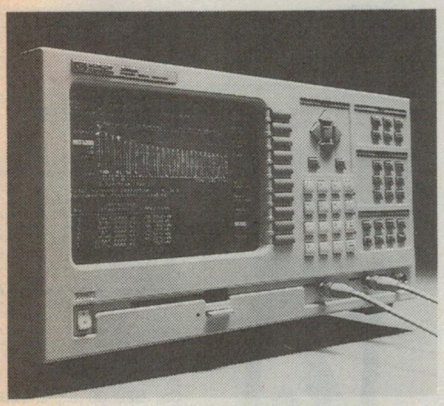
Further information from Interrupt Systems, 9 Robinlee Avenue, Burwood East, 3151 or (03) 233 9622.

Dynamic signal analyzer

Hewlett-Packard Australia has released a fast Fourier transform (FFT)-based analyzer that provides easier test

solutions faster and at lower cost.

The new HP 355660A two-channel dynamic signal analyzer includes many test and automation features that traditionally have required the use of an external computer. It addresses a wide



variety of applications in electronics, mechanical test, acoustics and other low-frequenccy areas, in both production/process and R&D environments. The HP 35660A provides spectrum analysis from DC to 102.4kHz and network analysis DC to 51.2kHz. The FFT provides 400 lines of resolution in both one – and two-channel modes. Complete alias protection and digital zoom ensure high-resolution measurements with warranted accuracy.

The analyzer has two input channels with 70dB dynamic range and a source that provides signals for stimulus-response testing. It measures linear spectrum, power spectrum, frequency response gain/phase, group delay, time history and power spectral density. A built-in 3.5″ disc drive, compatible with HP 9000 Series 200/300 workstations, stores traces, tables and HP Instrument BASIC programs.

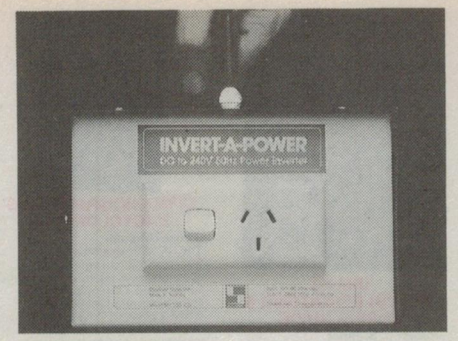
Further information from Hewlett Packard Australia, 31-44 Joseph Street, Blackburn 3130 or (03) 895-2895.

Australian made 240V 200VA inverter

Selectronics has released the latest addition to the Invert-A-Power Series of Australian designed and built inverters.

The new unit, the SPI-200 is available in 12 or 24 volt versions, both of which provide 200VA continuous power and intermittent output power of 425VA and 600VA respectively.

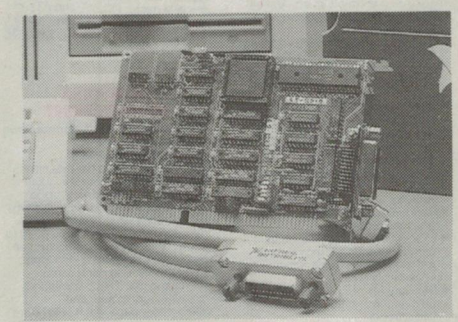
The SPI-200 has been developed in direct response to the demand for a "light-load" model for use in applications such as boating, camping, caravanning, outdoors and weekend holiday homes.



With this new unit, the user can operate a wide variety of domestic 240 volt appliances from a deep cycle 12 or 24 volt lead/acid battery. Typically, items such as TV's, lighting, calculators, computers, mixers, shavers etc. are all within the capacity of the SPI-200.

Weighing only 4.5kg and completely portable, the unit connects to the battery with conventional jumper leads – the appliance is then simply plugged in to the standard switched power point on the inverter. The SPI-200 is equally at home in fixed installations.

For further information contact Selectronic Components, 25 Holloway Drive, Bayswater or (03) 762 4822.



High speed IEEE-488 interface for PC/ATs

The National Instruments AT-GPIB is a new IEEE-488 interface for the IBM PC/AT and compatible personal computers equipped with 16-bit plug-in slots.

The AT-GPIB is claimed to be the first IEEE-488 interface developed specifically for the high-performance 80386 and 80286 based personal computers. It is a stand-alone, plug-in circuit card providing full-function, high-performance IEEE-488 interface functions. Data can be transferred between a computer equipped with the AT-GPIB and thousands of IEE-488 cables can connect the AT-GPIB with up to 13 additional devices or instruments (or more using a National Instruments IEEE-488 extender).

A computer configured with the AT-GPIB becomes an IEEE-488 controller that can be used for numerous applications in the areas of laboratory testing, production testing, and process monitoring and control.

The NEC UPD7210 GPIB interface controller implements virtually all IEEE-488 functions on the AT-GPIB, including Talker /Listener/ Controller (TLC) capabilities.

For further information contact Elmeasco Instruments, 18 Hilly Street, Mortlake 2137 or (02) 736 2888.

BOOKS

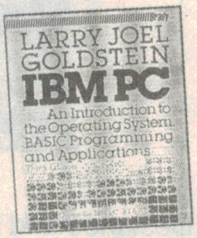
UNDERSTANDING UNIX

-James R. Groff, Paul N. Weinberg

The exploding popularity of the UNIX operating system is one of the most important trends in computing in the 1980's. UNIX is available on hundreds of different computers, ranging from personal computers to mainframes and supercomputers. *Understanding UNIX* offers an overall perspective on UNIX, including a discussion of where UNIX fits in the worlds of computing, business, and education. Individual chapters address the UNIX structure, file system, multiuser capability, specific applications tools, and more.

"A book that balances scope with depth; comprehensiveness with brevity." -Alan Kaplan

Cat.B21240 ..... **$44.95**



IBM PC

An introduction to the operating system, Basic programming, and applications.

-Larry Joel Goldstein

This classic and latest edition is the most comprehensive learning tool available for understanding and programming the IBM PC family. Features include a thorough explanation of the MS DOS and PC DOS operating systems, a "hands-on" approach to BASIC programming, chapters on memory, printer graphics, flow charting, file handling, games, screen graphics and sound.

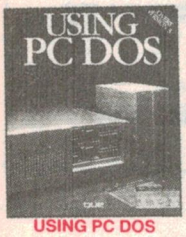
B20020 ..... **$39.95**

HANDS ON

Practical tips and useful programs for IBM PC's from the editors of PC World

A collection of the best tips, programs, and routines for IBM computers from the popular "Hands on" and "." columns. Covering both hardware and software, the book is organised so that you can quickly find information on virtually everything you need to know.

B20100 ..... **$34.95**



USING PC DOS

"Using PC DOS" is the only combination of a beginning tutorial, advanced guide, and lasting reference that gives you ultimate control over your PC's most important software: the operating system!

Beginners will learn how to...
- Prepare your diskettes
- Manage DOS directories
- Erase, rename, and copy files
- Print what appears on your screen
- Avoid disastrous errors

Advanced users will learn...
- Master path names
- Maneuvering through directories
- Customise DOS
- Use RAM disks
- Create AUTOEXEC.BAT files

Regardless of your level of expertise, you can use the Command Reference section to...
- Gain quick access to 63 most frequently used DOS commands
- Recognize valid DOS command phrasing
- Cope with frustrating DOS error messages

Cat.B20200 ..... **$49.95**

GETTING STARTED WITH THE IBM* PC* AND XT*

-David Arnold

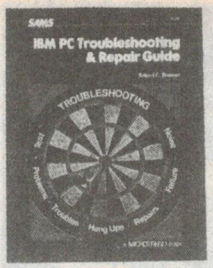
An authoritive guide from the PC World Library to using the PC* and its more powerful cousin, the XT*. If you're new to computing, you'll appreciate their tutorial approach, as you become familiar with keyboard, disks, and operating system (DOS 1·10 and 2·00). You'll learn to set up and handle electronic files, evaluate your software needs, and program in BASIC.

B20030 ..... **$34.95**

APPLE II ASSEMBLEY LANGUAGE

-Dr. Marvin L. De Jong
- Teaches assembly language programming at the beginning level - no prior knowledge of 6502 assembly language needed.
- Directs you in hands-on-computer exercises and experiments, with both software and hardware.
- Enables you to interface the Apple II to outside devices, eg: a/d and d/a converters, timers, etc.
- Provides interfacing circuits and programs that can be used on the Apple II without modification.
- Enhances your power as a programmer in your use of the Apple II.
- Gives you a more general understanding of how microcomputers work than can be obtained by programming in BASIC or any other high level language.

Cat.B20940 ..... **$36.95**



IBM PC TROUBLESHOOTING & REPAIR GUIDE

-Robert C. Brenner

Keep your IBM PC in top operating condition with this handy reference book. Inside you will find pages of schematics, photos and block diagrams to help you identify problems. Simple instructions tell you what's wrong and how to fix it fast.
- Make most repairs with few or no tools
- Quickly zero-in on a malfunctioning component
- Reduces downtime
- Pays for itself many times over in repair savings
- Easy to understand circuit diagrams.

The IBM PC Trouble Shooting and Repair Guide will make even the computer novice feel comfortable with the complex world of electronic trouble shooting. This fully illustrated book is recommended for anyone who uses an IBM PC.

Cat.B20115 ..... **$49.95**

DISKS, FILES AND PRINTERS FOR THE APPLE II

-Brian D. Blackwood,
-George H. Blackwood

Learn how to create and use text files while running a computer program, and to make hard copies of the results on a printer. Covers Apple II, II+, IIe, and Franklin Microcomputers. You will discover:
- Using the system includes booting DOS master, initializing disk, backup disk, accessing the drives, verifying, saving programs, and loading programs.
- DOS commands enable you to operate the disk drives and printer from the keyboard and to change languages (Integer BASIC to Applesoft or vise versa).
- Sequential files include creating, updating, reading, extending, refining, and multisection.
- Random access files are faster and take less memory.
- Executive files can be used to control a series of steps that do not require the operator to make keyboard inputs.
- Deficiencies of TAB and SPC can be overcome in 80 characters per line printers.

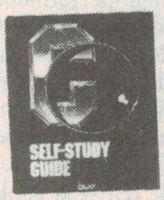
Cat.B20950 ..... **$34.95**

INTRODUCTION TO BASIC

-Jeffrey B Morton

This book is lucidly written, and is in two parts. The first teaches BASIC, and the second consists of a dozen carefully constructed projects. These are wide-ranging and set the language into the context of solving real-world problems. Each project is laid out with a set of variables to give the reader insight into the practical applications of the language. Any version of BASIC can be used to solve the projects and the other excellent examples scattered throughout the book.

Cat.B21245 ..... **$16.95**



"C" SELF STUDY GUIDE

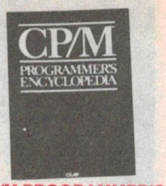
-Jack Purdum

Learn at your own pace as this self directed study guide takes you through the basics and into advanced areas of the C programming language. The unique format allows you to advance quickly or proceed slowly. The book is divided into two parts:

Questions: of varying degrees of difficulty to guide beginners over the rough spots and to challenge the more experienced C programmers.

Answers: that include many complete programs for testing new functions and for illustrating tips, traps, techniques and short cuts.

Cat.B20690 ..... **$37.95**

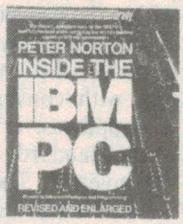


CP/M PROGRAMMER'S ENCYCLOPEDIA

-Bruce Brigham

The CP/M Programmer's Encyclopedia is a time saving, comprehensive reference for serious CP/M users. Covering all the commands and syntaxes for CP/M 2.x and CP/M 3.0, this encyclopedia gives you the information you need in an easy-to-use format especially designed for programmers. The CP/M Programmer's Encyclopedia is the only major compilation of CP/M commands and syntaxes. If you use CP/M extensively, you should not be without this important reference guide.

Cat.B21260 ..... **$44.95**



INSIDE THE IBM PC

(Revised and expanded edition)

-Peter Norton

The widely acclaimed guide to the IBM PC's inner workings. The latest edition now covers every model of the IBM micro: PC, XT and AT, and every version of DOS from 1.1 to 3.0

B20080 ..... **$44.95**

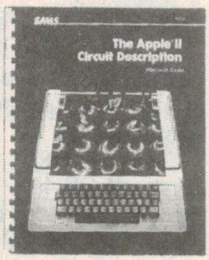
HARD DISK MANAGEMENT

For IBM PC XT, AT & compatibles

-Thomas Cain and
Nancy Woodard Cain

Now you can use a hard disk to its fullest advantage with this guide to managing your hardware using DOS, batch files, and menu systems. It introduces you to various disk management concepts you need to know, while providing step by step techniques for dealing with them. Key topis include partitioning, formatting, the TREE command, sub-directory usage, and file/memory capacity. It also offers extensive information about DOS along the way: how it fits in, and how hard it can work for you.

B20070 ..... **$39.95**



APPLE II CIRCUIT DESCRIPTION

-Winston D. Gayler
- Covers all Apple II motherboard and keyboard versions.
- Helps you learn about microcomputer hardware in general and Apple II hardware in detail.
- Provides you with accurate schematics and verified waveforms to rely on for servicing and repair.
- Explains the advanced concepts of daisy chains, interrupts, direct memory access, and the ready line.
- Gives you many valuable hints for successful interfacing.
- Contains tutorials on video signals, memory IC's and the 6502 microprocessor, as well as full explanations of advanced concepts.
- Each chapter contains an overview for the beginner and a detailed section for the more adventurous.
- Ideal for students, technicians, hobbyists, engineers, and others who need Apple II technical information.

Cat.B20960 ..... **$54.95**

INTERFACING TO THE IBM PERSONAL COMPUTER

-Lewis C. Eggebrecht

This book describes the interfaces, resources, and functions of the Personal Computer. While not presenting specific interface designs or projects, it provides information and techniques that can be used in various projects.
- Describes the components of the Personal Computer.
- Examines the processor card and its functions.
- Reviews the 8088 microprocessor.
- Discusses fully the PC bus system, its signals, its timing, its characteristics.
- Examines the system interrupts and the modes of operation of its timers and counters.
- Looks at the PC memories and describes its methods of data transfer.
- Describes interface signal conditioning and some BASIC interfacing commands.

Essential reading for everyone who owns or uses an IBM PC!

Cat.B20075 ..... **$34.95**

PASCAL PRIMER

-Mitchell Waite, David Fox

If you are learning programming or have dabbled in the popular language BASIC and wish to learn the capabilities of Pascal, this book is definitely written for you. Written and illustrated with a touch of humour, the informative text describes Pascal program structure, Pascal variables, Pascal procedures, and many other features. There are chapters on decision making statements, numeric functions, string functions, arrays and sets, and much more. The eight appendices present facts about the advantages and disadvantages of Pascal, components of a Pascal system, interfacing assembly language routines, and other useful information.

Cat.B21120 ..... **$34.95**

1-2-3 TIPS, TRICKS & TRAPS

-Dick Anderson, Douglas Cobb

Contains a collection of valuable techniques to help users of Lotus 1-2-3 get the maximum benefit from this powerful integrated software package. Designed as a quick reference, this book shows you hundreds of shortcuts, offers help with unexpected problems, and suggests techniques for using some of 1-2-3's little known capabilities.

Cat.B20140 ..... **$44.95**

1-2-3 BUSINESS FORMULA HANDBOOK

An invaluable source of tips and techniques for creating, editing, and using 1-2-3 formulas in a wide range of personal and business applications.

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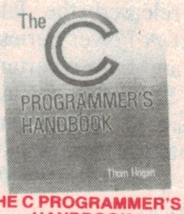

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-Gordon Letwin

A rare and exciting technical examination of the philosophy, key development issues, programming implications, and future of the MS OS/2 operating system. Gordon Letwin, Chief Architect for MS OS/2, provides a true behind the scenes view of the process of merging Microsoft's vision of an automated office system with the realities of software development. Here is revealing information every MS OS/2 programmer, as well as high tech and office automation specialists, will find invaluable.

Letwin discusses:
- The powerful graphics, true multitasking, hardware and software protection, and program "encapsulation" features that were incorporated into MS OS/2
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- The software architectural details from a design and programming perspective
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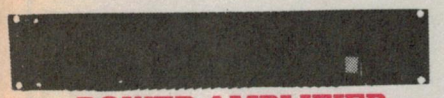

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SPECIAL, ONLY $399
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TOTAL HARMONIC DISTORTION: Determined by 2nd Harmonic Distortion (see above)
INTERMODULATION DISTORTION: 0.003% at 100W. (50Hz and 7KHz mixed 4:1).
STABILITY: Unconditional.

Cat. K44771 ..... **$449**
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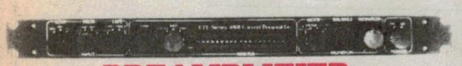

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FREQUENCY RESPONSE: High-level input: 15Hz =130KHz, +0.=1dB Low-Level input-conforms to RIAA equalisation +=0.2dB
DISTORTION: 1KHz ‹0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation).
S/N NOISE: High-Level input, master full, with respect to 300mV input signal at full output (1.2V)›92dB flat ›100dB A-weighted, MM input, master full, with respect to full output (1.2V) at 5 mV input 50ohms source resistance connected: ›86dB flat/92dB A-weighted MC input, master full, with respect to full output (1.2V) and 200uV input signal: ›71dB flat ›75dB A-weighted.

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Cat. K44590 ..... 1 unit: **$239**
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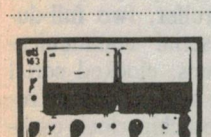
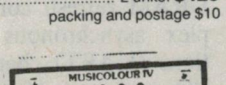


LAB SUPPLY

Fully variable 0-40V current limited 0-5A supply with both voltage and current metering (two ranges: 0-0.5A/0-5A). This employs a conventional series-pass regulator, not a switchmode type with its attendant problems, but dissipation is reduced by unique relay switching system switching between laps on the transformer secondary.
(ETI May'83) ETI 163

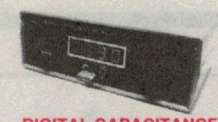
Cat. K41630 ..... **$249**



MUSICOLOR IV

Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug.'81) 81MC8

Cat.K81080 ..... **$114.95**



DIGITAL CAPACITANCE METER Mk.2

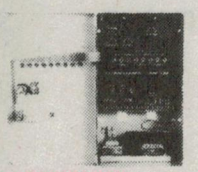
Updated from the EA March '80 issue, this Digital Capacitance Meter checks capacitor values from 1pF to 99.99uF over three ranges. Its main features include a nulling circuit and a bright 4 digit LED display.
***Note:** The RIE kit contains quality silk screen printed and prepunched front panel AND an exclusive High Intensity Display!
(85cm9a, EA August '85)

Cat. K85090 ..... **$99.95**

PLAYMASTER 300 WATT AMPLIFIER

This module will deliver up to 200 watts into an 8 ohm load and up to 300 watts into a 4 ohm load. Comprehensive protection is included and a printer circuit board brings it all together in a rugged easy-to-build module. It can be built in either fully-complemetary or quasi-complementary versions, so output transistor shortages should be no problem at all.
(80PA6) (EA July '80)

Cat. K80060 ..... **Normally $109**
SPECIAL, ONLY $99
(Heatsink not included)



MULTI SECTOR ALARM STATION

Protect your home and possessions from burglars with this up to the minute burglar alarm system. It's easy to build, costs less than equivalent commercial units, and features eight seperate inputs, individual sector control, battery back up and self-test facility.
Specifications:

- Eight sectors with LED status indication.
- Two delayed entry sectors.
- Variable exit, entry and alarm time settings: entry delay variable between 10 and 75 seconds; exit delay variable between 5 and 45 seconds; alarm time variable between 1 and 15 minutes.
- Resistive loop sensing: suits both normally open and normally closed alarm sensors.
- Battery back-up with in-built charger circuit.
- Built-in siren driver.

The RIE kit includes a superb printed and prepunched metal case and inside metal work, plus a gell battery! Unbeatable VALUE!

K85901 without battery backup **$134**
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SPECIAL, $129

50 W AMPLIFIER MODULE (ETI 480)

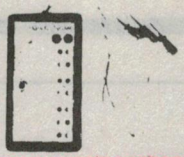
Cat. K44880 ..... Normally $31.80
SPECIAL, $21.95
(Heatsink optional extra)

100 W AMPLIFIER MODULE (ETI 480)

Cat. K44801 ..... Normally $34.80
SPECIAL, $28.95
(Heatsink optional extra)

POWER SUPPLY TO SUIT

Without transformer **$22.95**



TRANSISTOR TESTER

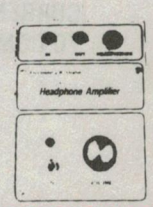
Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept.'83) 83TT8

Cat. K83080 ..... Normally $18.95
SPECIAL, $15.95

MUSICOLOR IV

Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug.'81) 81MC8

Cat.K81080 ..... **$114.95**



HEADPHONE AMPLIFIER

PRACTICE WITHOUT ANNOYING THE FAMILY!
If you play any type of electronic instrument,this headphone amplifier will surely interest you. It will let you practice for hours without upsetting the household,or you can use it to monitor your own instrument in the midst of a rowdy jam session. (EA Feb.'84) 83MA11

Cat. K84111 ..... **$39.95**

VIDEO AMPLIFIER

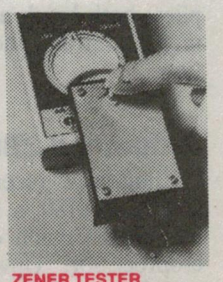
Bothered by smeary colours, signal beats and RF interference on your computer display? Throw away that cheap and nasty RF modulator and use a direct video connection instead, it's much better! The Video Amplifier features adjustable gain and provides both normal and inverted outputs. Power is derived from a 12V DC plugback supply...
(EA Aug.'83) 83VA8

Cat. K83081 ..... **$18.95**

CAR IGNITION KILLER

Most car burgular alarms are easily circumvented, but not this cunning "Ignition Killer". This sneaky antitheft device uses a 555 timer to place an intermittent short circuit across the points. Until disabled by its hidden switch the circuit effectively makes the car undriveable - a sure deterent to thieves! (EA Feb.'84) 84AU1

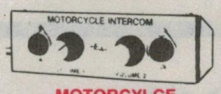
Cat. K84010 ..... **$24.95**
(Our kit includes the box!)



ZENER TESTER

A simple low cost add-on for your multimeter. This checks zeners and reads out the zener voltage directly on your multimeter. It can also check LEDs and ordinary diodes.
(ETI May'83) ETI 164

Cat. K41640 ..... **$11.95**



MOTORCYLCE INTERCOM

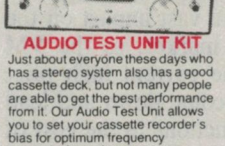
OVER 500 SOLD!
Motorcycling is fun, but the conversation between rider and passenger is usually just not possible. But build this intercom and you can converse with your passenger at any time while you are on the move. There are no "push-to-talk" buttons, adjustable volume and it's easy to build!
(EA Feb.'84) 84MC2

Cat. K84020 ..... **$49.95**

THE SCREECHER CAR BUGLAR ALARM

Here is a low cost car alarm designed with a new deterrent strategy. Instead of using the alarm to try to draw the attention of passers-by to the felony in progress, this alarm sounds inside the car, to deafen the thief and make it too uncomfortable to proceed with pinching the vechile!
(86a19, EA August '86)

Cat. K86081 ..... **$29.95**



AUDIO TEST UNIT KIT

Just about everyone these days who has a stereo system also has a good cassette deck, but not many people are able to get the best performance from it. Our Audio Test Unit allows you to set your cassette recorder's bias for optimum frequency response for a given tape or alternatively, it allows you to find out which tape is best for your recorder.
(81AO10) (EA Oct '81)

Cat. K81101 ..... **$59.50**

LOW-COST BIPOLAR MODEL TRAIN CONTROLLER

Here is a simple model train control for those enthusiasts who desire something better than the usual rheostat control. It provides much improved low speed performance and is fully overload protected, yet contains relatively few componenets. Best of all, you don't need to be an electronic genius to construct it. (80TC12) (EA Dec '80)

Cat. K80120 ..... **$39.95**

ELECTROSTATIC HAZARD DETECTOR KIT

It's called electrostatic hazard and if it, or even its baby brother, jumps on the back of your IC or transistor, then the poor device is never likely to be quite the same again. So, out of a very ordinary collection of bits and pieces, ETI has fashioned a black box that will sit quietly on a corner of your bench for years at a time and beep when ever high tension appears. It may save you a lot of trouble, particuly if you ever work with CMOS. (ETI 173 May '86)

Cat. K41730 ..... **$54.95**

READY-SET-GO LIGHTS

A simple project for starting slot car races, etc. It provides the traditional Red/Amber/Green lights with a random delay between the amber and green. (ETI Oct.'84) ETI 277

Cat. **$24.95**

EA AM STEREO DECODER

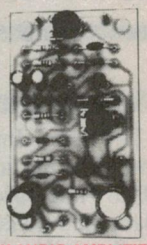
AM stereo is now broadcast in Australia on an experimental basis. This add-on decoder works with the Motorola C-QUAM system.
(EA Oct.'84) 84MS10

Cat. K84100 ..... Normally $26.95
SPECIAL, $16.95

CRYSTAL CONTROLLED TV PATTERN GENERATOR

Anyone wishing to obtain the maximum performance from a colour TV reciever needs a pattern generator. Why not build this superb unit which provides five separate patterns; dot, crosshatch, checker board, grey scale and white raster?
Note: The RIE kit includes a large ABS type case!
(80pg6, EA June '80)

Cat. K80033 ..... **$99.95**



1W AUDIO AMPLIFIER KIT

A low-cost general-purpose,1 watt audio amplifier, suitable for increasing your computers audio level, etc. (EA Nov.'84)

Cat. **$9.95**

BUZZ BOARD

Test your steadiness of hand with this updated version of an old game of skill. The "Buzz Board" is a sophisticated version of a simple game in which the player attempts to pass a small metallic loop along a bent wire path without making contact with that wire. The "Buzz Board" also features an adjustable time delay unit which means the buzzer will only sound if the metal loop touches longer than the set time. An fun kit to make and even more fun to use! (ETI 048)

WAS $4.50 NOW $3.25

15V DUAL POWER SUPPLY

This simple project is suitable for most projects requiring a dual voltage. Includes transformer.
(ETI 581, June '76)

Cat. K45810 ..... **$34.95**

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Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

386 compatible chip

To date, Intel has been the sole source of the immensely popular 32-bit 80386 microprocessor, as the Santa Clara chip maker has resisted all efforts to allow other firms to become alternate sources for the chip. But recently, a Japanese company, VM technology, announced it had developed a new processor that is fully compatible with the 80386 and which will be capable of running application software designed for the Intel processor.

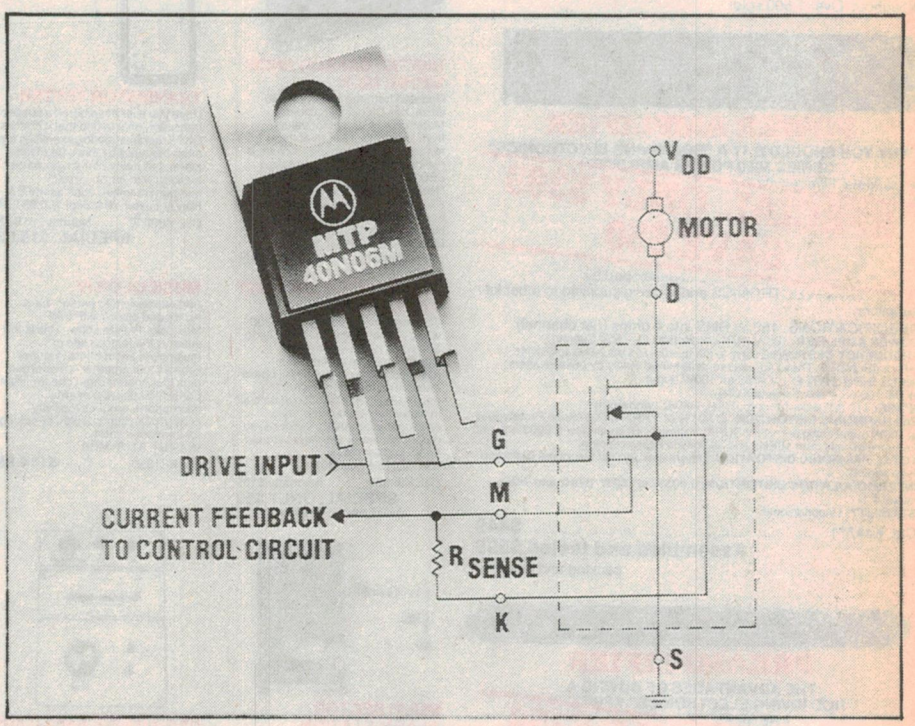
VM Technology is a joint venture between Mitsui, one of the world's largest trading companies, and ASCII Corporation, a Tokyo-based software and trade journal publishing company. The development could have a vast impact on the personal computer market, as the VM chip could force the current high price of the 386 chips to come down and lead to overall price reductions in the cost of 386-based products.

The development also means another major coup for ASCII founder Kay Nishi, who has played a major role in the industry since its formation in the mid seventies. Nishi also played a key role in helping Microsoft become a major force in the industry, as his company successfully marketed Microsoft's early Apple II products in Japan. Later, he also played a key role in the development of MS-DOS. In the early 1980's Nishi tried, and failed, to establish an alternate standard to the IBM PC with his modular and expandable MSX personal computer. While selling relatively well in Japan, MSX never caught on in the US Microsoft's failure to support MSX reportedly caused strains in the relationship between Nishi and Microsoft, where Nishi was vice president, and the two parted ways in 1985.

40-amp power MOSFET with current sensing

Motorola has introduced the MTP40N06M power MOSFET, a device with current sensing capabilities and rated at 40 amps, 60 volts with a maximum on-resistance of 40 milliohms. The device is housed in a 5-pin TO-220 package which dissipates 125 watts.

The current sensing capability allows the use of low power sense resistors, resulting in increased reliability, less board space and simpler circuitry.



Motorola's new 40-amp power MOSFET can operate at up to 60V and has a maximum on resistance of 40 milliohms.

The pinout includes the standard gate, drain and source of the MOSFET and includes a mirror and a Kelvin pin. The Kelvin pin is used to eliminate the voltage drop within the package, which would otherwise cause erroneous sense voltages resulting in an error in the current being sensed. The device mirrors the load current and reduces it by a factor of 900, reducing the power loss in the sense resistor considerably. This is particularly beneficial where large currents are being sensed.

Typical applications for this device are in current mode switching power supplies, both brush and brushless types of motor controls, and automotive applications.

Enhanced Z80 compatible

Zilog has recently announced the CMOS Z80180, a highly integrated and enhanced version of the 8-bit Z80 microprocessor. Upwardly software-compatible with Z80 code, the Z180 operates at an 8MHz clock frequency and incorporates key system functions on-chip that raise the performance of this 8-bit processor to 16-bit levels. The Z180 interfaces directly, with no external circuitry, to peripheral circuits designed for the Z80.

The Z180 incorporates an on-chip memory management unit that can address up to 1 megabyte of memory, and supports 64Kb of logical I/O space. Two direct memory access (DMA) channels support memory-to-memory and memory-to-I/O transfers. In addition to supporting the entire Z80 instruction set, the Z180 incorporates seven new high-level instructions including multiply (MLT). Other key features of the highly integrated Z180 include an on-chip wait state generator, a programmable DRAM refresh controller, two full-duplex asynchronous serial communications (UART) channels, clocked serial I/O port, two 16-bit programmable reload timers, and an on-chip clock oscillator and interrupt controller.

For further information contact George Brown Group Marketing Division, 456 Spencer Street, West Melbourne or phone (03) 329 7500.

150 MHz FET input op amp

The recently announced National Semiconductor IC type LH4117 is a FET-input wideband amplifier optimized for high speed, low gain applications. It is an ideal alternative to low precision open loop buffers and conventional operational amplifiers and it features a closed loop -3dB unity gain bandwidth in excess of 150MHz. Unlike conventional op-amps, the bandwidth is relatively independent of closed loop gain between 1 and 20. The device features rise and fall times of 3.3ns, a slew rate of 2500V/us (100 ohm load) and a 9ns settling time to 0.2%. A high current output stage is also incorporated, allowing the LH4117 to drive 50 terminated lines directly. This makes it an ideal choice for video distribution applications.

IBM goes to 8″ wafers

IBM is now in volume production on the first manufacturing line in the industry capable of fabricating semiconductor chips on 200mm (8″) diameter silicon wafers.

Until recently, the company processed 5″ wafers exclusively, each capable of yielding about 150 1 megabit RAM chips. Now it it possible to get up to 400 chips on an 8″ wafer in the same amount of time, providing significant increases in cost effectiveness and productivity.

The new manufacturing line is now augmenting production of the company's one-megabit dynamic random access memory (DRAM) chips. The company committed to develop 8″ production technology in 1984, requiring the building of a completely new semiconductor production line. IBM was the first to produce one-megabit DRAM chips in large volumes, and also the first to incorporate megabit chips in mainframe computers.

12-bit, 20MHz D/A converter

TRW LSI Products Division has added a new low cost D/A converter to its analog product line. The new product, the TDC1012 is a monolithic, 12-bit D/A converter which can convert digital data into analog current at maximum data rates up to 20MHz. Typical settling time is 30ns to within plus or minus 0.012% FSR for a full scale output change.

The TCD1012 on-chip data registers, precisely matched propagation delays and a segmented architecture reduce glitch area to a very low 25pV-sec, eliminating the need for external deglitcher circuits. The TDC1012 has been designed for excellent settling time performance when operating into a low impedance resistive load. The complementary 40mA current outputs can produce a 1V full-scale voltage when directly driving a doubly terminated 50 ohm transmission line.

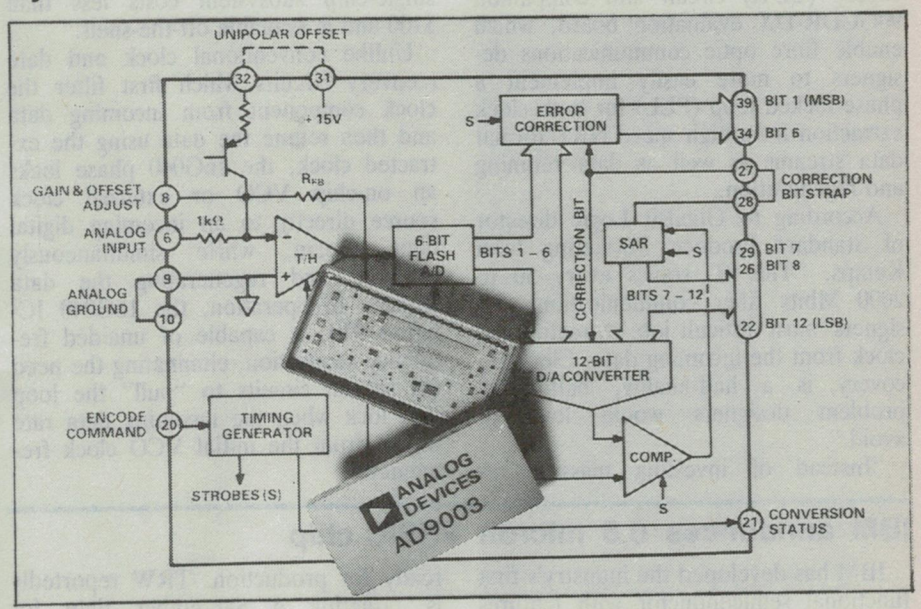
The new 12-bit D/A converter is currently available in two packages; a 24-lead plastic DIP and a 24-lead hermetic ceramic DIP. A 16-page datasheet on the TDC1012 is available for the asking by contacting Email Electronics, 15-17 Hume Street, Huntingdale, 3166. Tel: (03) 544 8244.

100MHz operational amplifier

Analog Devices' AD9610 wideband current feedback operational amplifier is now available in a version that conforms to MIL-STD-883B. The hybrid amplifier combines the dynamic performance, the excellent pulse fidelity and the good DC specifications required in miltary systems. Since the device uses current rather than voltage feedback, bandwidth is relatively independent of gain. The AD9610TH/883B offers a minimum -3dB bandwidth of 80MHz (G=-10) unity-gain bandwidth over the full -55 to +125°C temperature range. Military applications include communications, pulse repeaters, and radar signal processing.

Rise and fall times are less than 4.0ns maximum with a 5V step, maximum settling time is <25ns to 0.1% and guaranteed minimum slew rate capability is 3000V/us. The AD9610TH/883B is packaged in a 12-pin TO-8 metal can, operates from ±15V supplies and consumes a maximum 750mW. Further information from Parameters, Centrecourt PO Box 261, North Ryde, NSW or phone (02) 888 8777.

Hybrid 12-bit ADC guarantees true 1MHz conversion rate

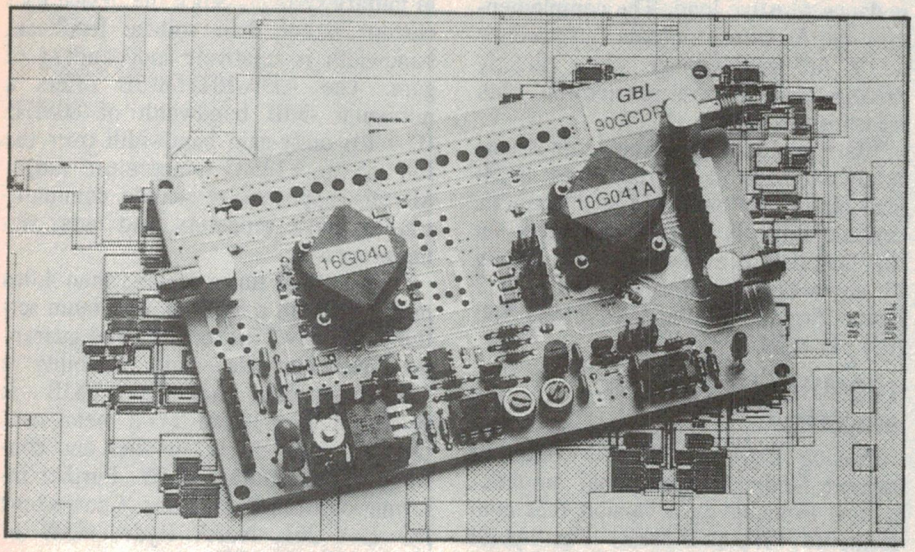


A new hybrid device from Analog Devices combines a 12-bit analog-to-digital converter (ADC) and track-and-hold-amplifier (T/H) in a single package. The AD9003's maximum conversion time of 85ns – including acquisition time – ensures true 1MHz performance. Combining an ADC and T/H in the same package permits complete AC and DC characterisation of the device; the AD9003 guarantees 74dB minimum harmonic distortion, 65dB minimum signal-to-noise ratio, and 87dB typical two-tone intermodulation distortion. Accuracy specifications include: ±1LSB maximum differential nonlinearity, ±1.5LSB maximum integral nonlinearity, ±0.2% maximum full-scale gain error, and no missing codes over the full operating temperature ranges.

The AD9003 suits applications such as radar systems, digital oscilloscopes, and high-speed data acquisition. The small 40-pin DIP saves board space, especially over competing devices that require a separate external track-and-hold. Typical 2.2W power dissipation reduces cooling requirements in weight-critical avionic applications.

For further information, contact Parameters, 25-27 Paul Street Nth, Nth Ryde 2113 or phone (02) 888 8777.

Solid State Update



Clock/data recovery works at 2Gbps

GigaBit Logic in California has announced its 16G040 Clock & Data Recovery (CDR) circuit and companion 90GCDR-DX evaluation board, which enable fibre optic communications designers to more easily implement a phase locked loop (PLL) for both clock extraction from high speed NRZ format data streams as well as data retiming and regeneration.

According to GigaBit Logic director of Standard Products Marketing John Kemps, "This IC solves every 50 to 2000 Mbits fiber communications designers' most difficult job: extracting the clock from the incoming data. Clock recovery is a half-analog, half-digital problem designers would love to avoid."

"Instead of investing massive resources to develop still another complex ASIC or board solution, our low-power, single-chip subsystem costs less than $100 and is available off-the-shelf."

Unlike conventional clock and data recovery circuits which first filter the clock component from incoming data and then retime the data using the extracted clock, the 16G040 phase locks an on-chip VCO or external clock source directly to an incoming digital data stream, while simultaneously retiming and regenerating the data stream. In operation, the 16G040 IC-based PLL is capable of unaided frequency acquisition, eliminating the need for special circuits to "pull" the loop into lock when the incoming data rate differs from the initial VCO clock frequency.

IBM announces 0.5 micron VHSIC chip

IBM has developed the industry's first functional semiconductor with features smaller than half a micron.

The revolutionary signal processing chip was developed at IBM's Federal Systems Facility in Manassas, Virginia under the Pentagon's VHSIC (very high-speed integrated circuit) program.

"This is a significant technological milestone for IBM and the US Defence Department," said William Gianopulos, director of the IBM laboratory in Manassas.

Although other VHSIC contractors have developed components with half-micron features, including TRW and Honeywell, their products are still in the development process. IBM's components, on the other hand are ready for production. TRW reportedly is targeting a September date for starting production of its "self-healing" VHSIC superchip, which will contain no less than 4 million transistors.

The IBM chip, by comparison, contains about 100,000 transistors and can be used to capture and process high-frequency radar, sonar and other signals.

In the commercial markets, chips with half-micron features are probably still three to five years away, as leading companies like Intel, AMD and others are just now starting to build research labs to handle the development and low-volume production of wafers with such advanced lithography and processing requirements.

5-chip AT compatible chip set runs at 16MHz

The Arizona-based Application Specific Logic Products Division of VLSI Technology Inc. (VLSI) has introduced the VL82CPCAT-16, a 16MHz "no wait state", high-integration, five-chip set that greatly reduces the device count on the motherboards of IBM PC/AT-compatible computers. The fully PC/AT-compatible chip set reduces the non-memory device count from 88 industry-standard devices to 15 integrated circuits (ICs), or 83%.

The new 16MHz VL82PCAT-16 set is a significant upgrade of the popular 12MHz VL82PCAT set now in production. It is claimed to provide the system designer with the highest performance possible in standard 16MHz '286-based PC/AT-compatible systems. In addition to the 33% speed improvement, the chip set now allows a significantly faster access to protected memory with an on-chip "hot reset";

on-board clock modulation which permits operations on slower expansion cards in the 16MHz system environment; and a new "shadow RAM" feature which speeds performance further by bypassing ROM access delays.

The five devices in the VL82CPCAT-16 chip set have been designated the VL82C100 PC/AT Peripheral Controller, VL82C201 PC/AT System Controller, VL82C202 PC/AT Memory Controller, VL82C203 PC/AT Address Buffer, and the VL82C204 PC/AT Data Buffer.

Further details are available from Energy Control International, 26 Boron Street, Sumner Park 4074 or (07) 376 2955.

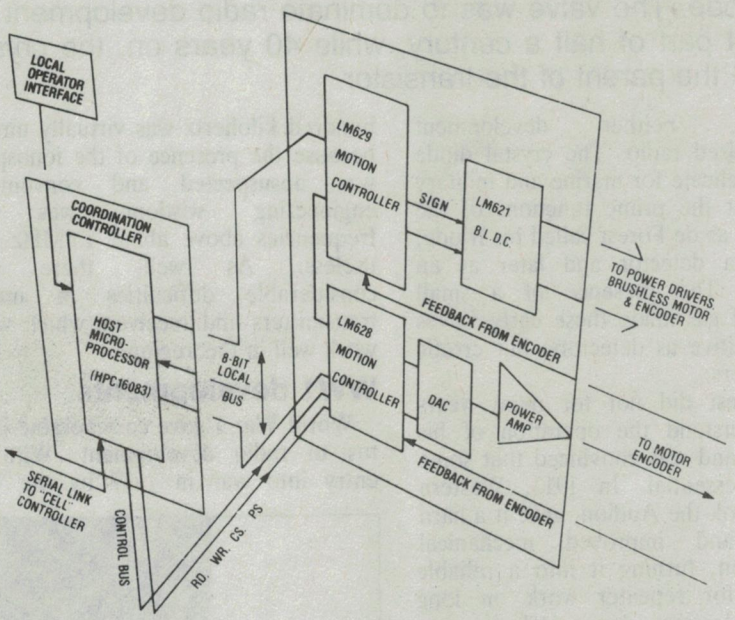
Dedicated Motion Controllers for Precision Control of DC Servo Motors

Until now, high performance servo motor systems were a slow trial and error process, requiring the expertise of several engineering talents.

However, National's new LM628/629 Dedicated Motion Controllers have changed all that. They eliminate the need for diverse engineering expertise, dramatically reduce software and hardware development efforts down to a few days, plus offer a new level of enhanced motion-control performance and communications with the host system.

The National LM628/629 are the only motion controllers on the market today which incorporate real-time programmable host-interrupt capabilities, trapezoidal velocity profile, and correction for positioning errors.

As National Semiconductor's most experienced distributor, NSD has the stock, expertise and Australia-wide support for the comprehensive range of National and Fairchild products:



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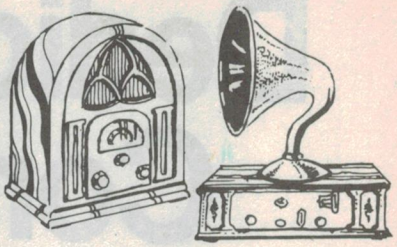
Vintage Radio

by PETER LANKSHEAR



Early receiver developments

There can be little argument that the two most significant developments in the history of radio were made in 1906, when several crystal detectors were patented and Lee de Forest invented the triode valve by putting a grid into Fleming's diode. The valve was to dominate radio development for the best part of half a century, while 40 years on, the crystal became the parent of the transistor.

Initially, neither development revolutionised radio. The crystal diode was too delicate for marine and military use, whilst the prime functions of the "Audion" as de Forest called his triode, were as a detector and later as an oscillator. The presence of a small amount of gas made these early valves more sensitive as detectors, but erratic as amplifiers.

De Forest did not for many years fully understand the operation of his invention and was convinced that some gas was essential. In 1913, Western Electric took the Audion, gave it a hard vacuum and improved mechanical construction, turning it into a reliable amplifier for repeater work on long distance telephone circuits. These same WE valves made possible the first transcontinental telephone circuit from New York to San Francisco, in 1915. As was often the case, parallel development was taking place in Europe.

It should not be assumed that early radio receiving systems were insensitive. By the use of large and efficient tuned circuits fed from massive aerial systems, quite remarkable performances were possible, even with primitive diodes as detectors. The Audion valve was slow to receive commercial acceptance until 1913, when a student at Columbia University, Edwin Armstrong invented regeneration, or positive feedback around a triode detector. This gave a dramatic increase in sensitivity.

At this time, radio transmissions used what is now the bottom end of the spectrum. The region above a few hundred kilohertz was virtually unused, because the presence of the ionosphere was unsuspected and conventional engineering wisdom was that frequencies above about 1.5MHz were useless. As well, there were considerable difficulties in making transmitters and receivers which would work well in this region.

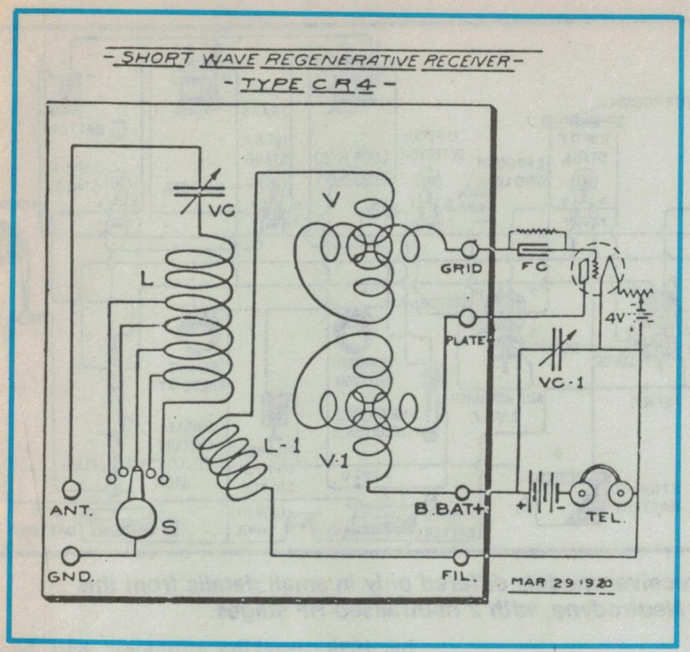
WW1 developments

World War 1 gave considerable impetus to radio development. With the entry into war in 1917 by the USA Armstrong, who had by now graduated, was given an Army commission and sent to France to carry out research. The Americans were convinced (erroneously, as it turned out) that somehow the Germans were communicating with frequencies around 3000kHz and Armstrong was asked to devise a very sensitive receiver to monitor them.

Existing valves were inefficient at such high frequencies and even his regenerative detector was ineffective. Armstrong's brilliant answer, the superheterodyne, was announced just as the war ended in 1918 and was eventually to have a profound influence on receiver design for all time. The subsequent history of the superheterodyne is an absorbing story which we will cover in the future. It is sufficient to say for the moment that it did not come into its own for another decade.

It was left to another type of receiver, the tuned radio frequency or "TRF" set to be the workhorse of the 1920's and, along with the horn speaker, to become

The 1925 Freed Eisemann was a typical 5-valve TRF, with 3 tuning controls and 2 filament rheostats for controlling gain. The hinged lid was almost universal at this time.



The circuit for the Grebe CR4 of 1920, typical of pre broadcasting era receivers. The valve was separate from the receiver cabinet. With 2 variable capacitors, two "variometer" variable inductors, a tapped inductor and a filament control it demanded a lot of skill, but results could be impressive.

the symbol of early broadcasting.

Whilst the US Army was concerned with non-existent German HF transmissions, the Navy was having a real problem. When receiving weak low frequency signals, their receivers were suffering from interference from strong local 500kHz transmissions. The Navy requested L.A. Hazeltine, then Professor of Electrical Engineering at the Stevens Institute of Technology, to design a new receiver. To avoid the interference problem, one of its features was to have minimum capacitive coupling between the aerial and secondary tuned circuits. His remedy was to cancel or *neutralise* the effect of the capacitance by the use of a separate coil.

A typical amateur receiver of 1920 was the Grebe CR4, the circuit of which is shown in Fig. 1. "Short Wave" indicates that it covered what is now the broadcast band. The variable capacitor VC and coil L tuned the aerial circuit, the main tuning and regeneration being by variable inductors V and V1 called *variometers*. Note that the detector valve was separate from the receiver. More gain could be provided by adding a two stage audio amplifier.

The controls of a receiver like this all interact, demanding a fair amount of skill to use. A few radio telephone stations were to be heard, but most transmissions were Morse, many still from spark transmitters. By now improved valves, including the UV 201 (shortly to be modified to the famous 201A) had appeared.

In America, radio broadcasting as such began during 1920. Naturally, the "ham" fraternity were involved, often using home built regenerative receivers. Marconi engineers in Britain were also experimenting with radio broadcasts. There, economics were such that only crystal sets or very simple one or two valve receivers were affordable by the average user. Oscillating regenerative detectors create interference, so their use was discouraged.

By the end of 1923, England was covered by a network of BBC transmitters of reasonable strength, and modest receiver sensitivity was sufficient. Consequently, during the 1920's English receivers were generally simple.

American conditions were different – as they were in Australia and New Zealand when radio came to this part of the world. Away from the cities, long distances from transmitters meant that receivers had to be sensitive and stable. The regenerative detector is remarkably efficient, but its sensitivity falls off rapidly with weak signals, and as mentioned previously, it radiates interference badly if used carelessly. A receiver was required that was stable, sensitive and easily tuned by unskilled users.

Armstrong's superheterodyne was not sufficiently developed. Meanwhile he had discovered super regeneration which initially showed great promise. Capable of phenomenal performance from just two valves, super regeneration was later to be successful at VHF in radar and communications, but for broadcast work, it proved to have inadequate selectivity.

Different solution

What was needed was amplification prior to detection. Valves that would amplify at RF were now available, but to achieve a worthwhile amount of gain and to provide a reasonable degree of selectivity, tuned amplifiers would be necessary. However, a valve with tuned circuits at both its grid and anode becomes a healthy oscillator. This occurs because the unavoidable small capacitance between the grid and anode inside the valve feeds sufficient energy back to the grid to cause the valve to oscillate.

One way of preventing this problem would be to cancel the effect of this capacitance. Professor Hazeltine worked on the problem and in 1923 demonstrated a solution based on his Naval work of 1918. In this he "neutralised" the grid plate capacitance by feeding a *phase reversed* signal from the anode circuit back to the gird via a very small adjustable capacitor. Correctly adjusted, this permitted stable RF amplification and by 1924 the "neutrodyne" tuned radio frequency (TRF) receiver was being sold in increasing numbers.

The TRF was very successful and soon took on a standardised form using 5 valves. There were two tuned RF stages, a grid leak detector generally without regeneration, and two transformer-coupled audio stages feeding a horn loudspeaker. Each RF amplifier and the detector had tuning capacitors with separate knobs which, along with a couple of filament control rheostats, presented a pretty fearsome array to the non technical user.

As a very small boy, I remember my grandfather tuning in Melbourne on a 1925 Federal Neutrodyne. No one else had the confidence to attempt the task. In these receivers, the dials do not track and unless all three are tuned "on the nose" nothing will be heard. Careful tuning in small increments is essential. Naturally, an important part of the operation was to write down or "log" all the settings for future reference!

Radio takes off

By 1925, America had gone radio mad. Literally dozens of manufacturers were making millions of receivers, the vast majority being the standard "three-knob" TRF.

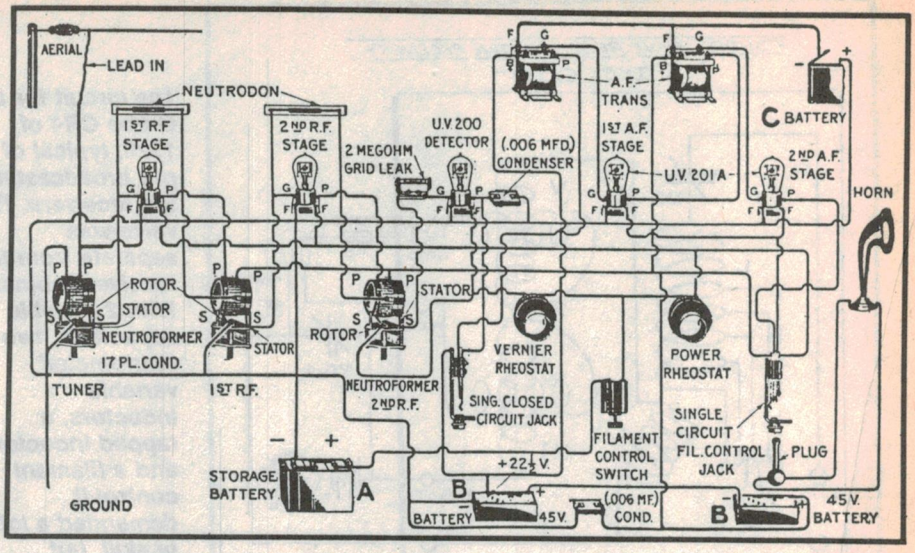
Many companies resented paying Neutrodyne royalties to Hazeltine, and extensively used alternative ways to stabilise RF amplifiers. One method was to connect resistors of a few hundred ohms in series with the RF amplifier grids. The idea was to introduce sufficient losses to balance the tendency towards positive feedback. Another less elegant method was to return the grids of the RF valves to the positive end of

the filament. This biased the grid positively, causing the valves to load the tuned circuits and again damp down any tendency to oscillate. This was a poor method, leading to short battery and valve life. Amplifiers stabilised by these methods were in no way as effective as well designed neutralised amplifiers.

Here was now a receiver of adequate performance, but with the serious problem of being difficult for the non technical user to operate. Attempts were soon made to couple the tuning controls together, one of the most ingenious coming from Grebe with their "Synchrophase" receivers whereby the three controls were connected by chain drives and clutches.

A later Grebe used an incredible linkage of "Meccano" parts to couple five capacitors together, whilst Atwater Kent used phosphor-bronze belts.

Two problems arose with "ganging" as it was called. One was was wide tolerances between tuning capacitors. The other was that, although RF stages could be made to track well enough, aerial tuning circuits created problems through being affected by the characteristics of individual aerials connected to them.

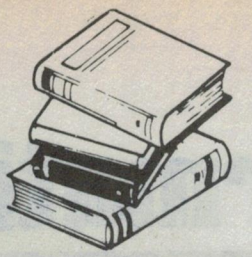


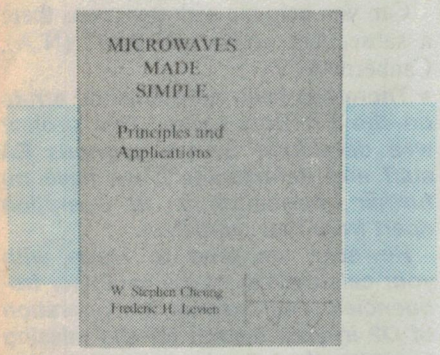
Dozens of 1925 receiver models differed only in small details from this Standard 5-valve Neutrodyne, with 2 neutralised RF stages.

One solution was to couple the amplifier and detector stages, but to have separate aerial tuning. This reduced the tuning to a two-handed exercise instead of three! A less satisfactory method was to directly couple the aerial without the benefit of tuning, to the grid of the first valve – leading to problems of cross modulation and harmonics. However, by 1928, tracking problems had been largely overcome and the TRF had reached the stage of being a reasonably useful and useable receiver.

There were to be two further major developments before the end of the decade. Both were to have a profound influence on radio design and will be described next month. I hope you can join me!

Books & Literature





Microwave text

MICROWAVES MADE SIMPLE: Principles and Applications, edited by W. Stephen Cheung and Frederic H. Levien. Published by Artec House Inc., 1985. Hard covers, 287 x 223mm, 356 pages. ISBN 0 89006 173 4. Also accompanying workbook, ISBN 0 89006 204 8.

Quite an interesting book, this one. It was written to provide an easy to understand basic introduction to the technical side of microwave electronics, for engineers, technicians and others working in the industry. The authors are all staff members of the Microwave Training Institute in Mountain View, California, which was set up by the US electronics industry because it was believed that too many people working in this field didn't have a good enough grasp of the technical concepts and specialised devices used in the microwave area.

As the director of MTI explains in his foreword, conventional microwave textbooks seem to get bogged down in deep maths, and the physical understanding of the devices and techniques is often lost. The idea of *Microwaves Made Simple* was to explain the operation of even the most complicated devices and principles using physical explanations, with only the most basic of maths and the emphasis on practical engineering.

Frankly I think it has achieved this aim exceptionally well. Right from the start the explanations are clear, easy to follow and down to earth, and they remain so all the way through.

The book starts with basic microwave theory and terminology, dealing with the concepts of transmission lines, attenuation, insertion loss and return loss. Then there's an introduction to the Smith chart, allowing it to be used to explain the concepts of matching.

Later chapters then deal with microwave devices (both tubes and solid state), low-noise receivers and antennas. Finally there are chapters discussing the manufacture of devices and the application of microwave systems in radar, satellite communications, electronic warfare, television and health sciences – plus a look at future possibilities.

In short, it's comprehensive in scope as well as highly readable. There's even an optional workbook, for use when the book is used as a college text.

I can't remember having seen a better introduction to this important area of electronics and communications.

The review copy came direct from the publisher in the USA. (J.R.)

Astronomy guide

THE SOUTHERN SKY, by David Reidy and Ken Wallace. Published by Allen & Unwin Australia, 1987. Soft covers, 229 x 179mm, 182 pages. ISBN 0 04 300094 0. Recommended retail price $19.95.

I'm not sure exactly why this book was sent to *EA* for review. Perhaps the publisher felt that many of our readers are basically interested in many aspects of science, and would therefore have an interest in astronomy as well as subjects more directly related to electronics.

As far as I can judge, it seems to be a well-written and highly readable introduction to the subject, written for people with an interest in astronomy but no prior knowledge. The emphasis is on practical astronomy, the kind of things you'd need to know in order to try it out as a hobby.

I should add that the emphasis is on optical astronomy – there's virtually nothing about radio astronomy, which might well have been of somewhat greater interest to *EA* readers.

The other main point to note is that it has been written in Australia, and therefore discusses the sky and the astronomical scene from the local viewpoint (not all that common, unfortunately). There's even such useful things as a list of astronomical societies in Australia and New Zealand, and latitude/longitude data for many of the larger cities and towns in both countries.

For those with a hankering to spend their evenings peering through a telescope (and don't get me wrong, it can be fascinating!), it should be very worthwhile. I'd just like to see a similar book on elementary radio astronomy for amateurs – after all, Australia has been a leader in this field for many years!

The review copy came from the publisher, but I understand that the book is in stock at all major and technical bookstores. (J.R.)

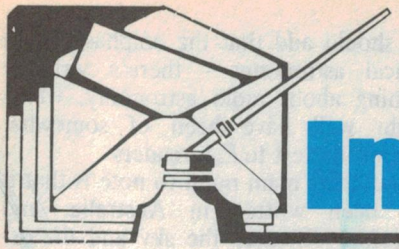
Telephone systems

INTRODUCTION TO TELEPHONES AND TELEPHONE SYSTEMS, by A. Michael Noll. Published by Artech House, 1986. Soft covers, 230 x 153mm, 177 pages. ISBN 0 89006 203 X.

There always seems to be at least a basic level of interest in telephone systems among electronics people, even though in the past at least these systems haven't involved a great deal of electronics. This book should therefore meet with a good reception, even though it's written from a US viewpoint. The author is a member of the academic staff at the Annenberg School of Communications, at the University of Southern California.

It's by no means a highly academic text, however. Quite the opposite – I would describe it as a very broad and highly readable introduction to the sub-

continued on page 141



Information centre

Bucket brigade device

The query I have concerns a project which was printed in the June issue 1983 issue, titled "Versatile effects unit for Creative Musicians", by Colin Dawson.

I realise the project is an old one, but on nearing completion I find that one component is unavailable in New Zealand. I am hoping very much if you could tell me where, if possible I could manage to buy some in Australia.

The component in question is the Matsushita MN3001 Bucket Brigade Device (BBD). I would also appreciate it if you could tell me the price (M.D, Auckland NZ)

• The MN3001 Bucket Brigade IC is listed in the Jaycar catalogue as Cat. No. ZK-8801, at a price of $24.50. You can order it from Jaycar Pty Ltd at PO Box 185, Concord, NSW 2137 – or use the order form on page 126 of the catalog, which appeared as a supplement to the March 88 issue. The post and packing charges for the IC would be $3.75.

60-60 Amplifier

I have recently constructed the Ea Sixty-Sixty Stereo Amplifier. After careful assembly and double checking all components wiring etc, I powered the unit up. Everything was OK until it came to setting up the quiescent current, which was very unstable.

Q9, Q10 and Q11 all get hot (both channels) and the quiescent current varies when the above transistors are fanned, even quite lightly. I have checked the components and wiring many times and also had a technician check the above; all was OK. All voltages on the circuit were checked and found to be OK (except of course those associated with the problem). However rail voltage was found to be +55V and −55V – is this too high?

Needless to say I have not attempted to run the amp. Hoping you can shed some light on this problem as I am very keen to get this unit up and running. (R.J., Artarmon NSW)

• The problems with your amplifier may be due to thermal runaway or supersonic oscillation. These subjects were covered in some detail in the May 1987 issue, in an article entitled "Feedback on the Playmaster 60/60 Amplifier". A photocopy is available from this office. See the reader services section in the rear of the magazine.

However, the high supply rails are a little unusual and may be compounding your problems. This voltage level would indicate a transformer secondary of 39-0-39 volts AC, or a mains (primary) voltage of about 270 volts AC!

Perhaps these voltages should be checked to find the source of the increase. Also, a high secondary may correspond to a similar increase in the 15 volt windings.

Quiz Game

I constructed the EA Quiz Game presented in the October 1985 edition, and it works quite well. However, I have not been able to get the chime circuit to operate correctly with a tremolo effect.

Referring to the circuit diagram, the chime circuit is based on two Schmitt oscillators – IC4d providing the basic chime at around 800Hz, and amplitude modulated by a control voltage provided by IC4f at around 1Hz. Associated transistors Q1 and Q2 provide shunting and decay characteristics to the various signals to give the tremolo effect.

My problem is that I am unable to get anything but the basic chime effect (around 400Hz) without any tremolo. Looking at the circuit I cannot understand why this is so. In theory this should mean that the control voltage (1Hz) coming from IC4f is not operating correctly. Frequency measurements however, indicate that it is operating correctly, albeit at around 0.5Hz.

Calculations of the frequencies of the two Schmitt oscillators using the standard formula give 0.3Hz and 368Hz respectively, and this is borne out in practice by actual measurements. This differs from the 1Hz and 800Hz mentioned in the article.

I have even varied the timing components so that in practice each oscillator is actually putting out 1Ha and 800Hz, but this still does not give the tremolo effect. In any event I would doubt that this would have a great effect except to vary the depth of the tremolo sound.

Can you help me with this – was there a subsequent errata published? (N.A., Canberra ACT)

• There has been no published errata on the EA Quiz game. This project was developed by the previous EA staff and unfortunately, we have no further information on its operation apart from that published.

However, we tend to agree with your calculations of the oscillator frequencies, and suspect the operation of Q2 in your search for the missing tremolo effect. Try lowering the value of the 10uF capacitor at the base of Q2. Its high value may be restraining the oscillator output at the base of Q2, and therefore preventing its conduction. Alternatively, the voltage divider formed by the 100k and 10k resistors may not be allowing enough drive to Q2, particularly if the supply voltage is a little low.

It the 800Hz tone has the correct attack and decay characteristics, we may assume that Q1 is operating correctly. If this is not the case, it is also under suspicion and its base drive circuitry should be checked.

Philips speakers

I built the Philips 30 W vented 3-speaker system described in your February, 1976 issue. Recently, I noticed that the high frequency performance was lacking. Closer inspection revealed that both tweeters no longer worked.

I contacted the local distributor of Philips speakers, and was advised that the AD0160 was no longer available. The distributor suggested that the AD0140 would be a satisfactory replacement. I am dubious about this recommendation because I seem to recall that the ADO140 was around at the time the speaker system was designed; presumably the designer considered the various Philips tweeters that were available and selected the ADO160 in preference to the ADO140.

I have noticed an advertisement for a Philips AD11610 tweeter and presume from the numbers that it is the replacement for the ADO160. However, unlike the ADO140, the AD11610 is not a drop-in replacement but will require some woodworking. Ideally, I would like to find a source of the ADO160

but, failing that, I would be grateful for your advice in selecting a suitable replacement. Obviously, there are two considerations: a) the ease of replacement, and b) electrical/acoustical suitability.

When I fit the replacement, I would like to avoid a recurrence of the problem and have considered the installation of PTC thermistors. Should I fit a thermistor to each speaker unit (i.e. one for the new tweeter, one for the AD0210 midrange and one for the AD8066 woofer)? Can these be fitted in series with the speakers without affecting the crossover's (ADF600/4000/—B) performance? Will they affect the acoustic performance of the system? Which thermistor should be used for each? (K.L.B., Ringwood Vic)

• Unfortunately, we do not know a source for the Philips AD0160 tweeters, which appear to have been discontinued. As you have suggested, the AD11610/T8 is probably the most compatible replacement. However, we have not tried this combination and cannot guarantee the results; your ears will be the best judge here.

In normal circumstances, the PTC polyswitches exhibit a very low impedance and should not effect the system's general performance. The most economical level of protection is to add a PTC device in series with the tweeter only. Since the tweeter is the most vulnerable unit (as you have experienced), this should significantly increase the protection.

The RN3410 device as available from Jaycar Electronics is suitable for this purpose.

Fax as scanner?

I am hoping you might be able to help me with a problem I have.

I am trying to find a reasonably simple means of using the output of a Fax to provide the input to a computer (IBM compatible). The prime reason for this is to use the Fax as a scanner to copy material as art work for a simple desktop publisher, however the system would also provide an invaluable (although memory hungry) means of filing documents containing graphics.

Providing the means could be found to provide a screen copy of the Fax signal, a simple program such as Snapshot would provide a usable file for processing. While this would provide a graphics rather than document type file, in some cases this would be advantageous because of extra security from editing.

As most offices are not using both Fax and computers I would have thought a system to combine both would be available commercially. However this seems not to be the case that I have found, although there are systems that are both over complicated and extremely expensive.

If a system of this type would have sufficient general interest to Ea readers, perhaps it would make the basis for a construction project. In any case I would appreciate any assistance you would provide. (B.K.P., Balya WA)

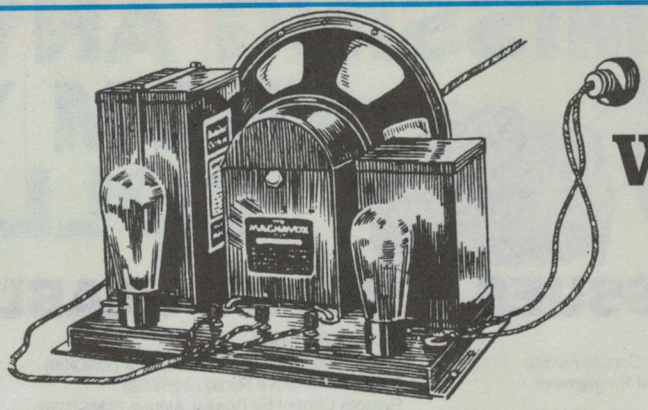
• We'll look into it, B.K.P., although it seems a fairly tall order. The modem in a fax machine sends the information in a form which may not be easy to decode.

Switch-mode supplies

Please dedicate an article, or series of articles, explaining the fundamentals and design of Swith Mode Power Supplies. Perhaps some inclusion concerning fault finding, dummy loads etc., can be made.

Keep up the good work in producing a very informative magazine. (G.R., Meadowbank NSW)

• We published quite a comprehensive article on Switcher fundamentals in the February 1988 issue, G.R. That should do for starters. We'll see if we can come up with more on the subject soon.



WHAT WAS IT?

Our mystery object this month is typical of units which appeared on the market in the late 1920's. It came for the then rather princely sum of 45 pounds – not including the two valves visible, which cost an additional 5 pounds. Can you guess what it did?
(Answer next month)

Answer for August:

Last month's mystery item was an audio interstage coupling transformer, used to couple audio signals from the output plate circuit of one valve to the input grid circuit of the next stage – while blocking the DC voltage. The primary side was marked P and B+ (meaning the valve plate and the positive side of the high tension or B battery respectively), while the secondary side was marked G and C- (meaning the valve grid and the negative side of the bias or C battery).

Later valve circuits used resistance-capacitance coupling between audio amplifier stages, and interstage coupling transformers tended to fall into disuse. However similar but rather smaller transistors were used in the first transistor radios and amplifiers, and are still used in some of the cheaper personal portables.

NOTES AND ERRATA

PLAYMASTER 30-30 AMPLIFIER (August 1988): The circuit diagram incorrectly shows pin 6 (positive supply) of IC4 connected to the left hand side of R27. Pin 6 should connect directly to the +30V rail on the right hand side of R27. (File: 1/SA/80).

LINE FILTER & CONDITIONER (July 1988): We have been advised that the 250VAC rated capacitors specified for this project are not polycarbonate types, but PTFE or PTFE/paper types.

Also with the capacitor values specified, the earth leakage current passed by the filter will exceed the value of 1mA RMS specified in Australian safety standard AS3145 (1979). To reduce the leakage current to an acceptable level, C1 and C2 should be reduced in value to 1nF (rated as before for 250VAC working). As this will tend to reduce the efficiency of the filter, we recommend that when this modification is done, a third and additional 1nF/250-VAC capacitor be connected between the active ends of C1 and C2 (i.e., directly between the A and N input lines). (File No.2/LF/9)

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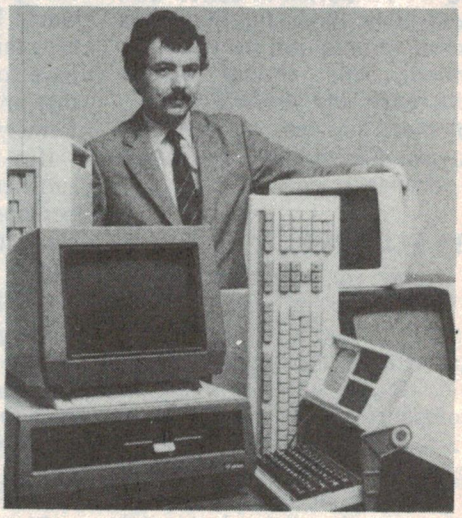

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Letters

continued from page 7

being renovated (the active was touching the case of an ironclad switch in the switchbox).

A "functional earth" could fairly be described as an earth connection which functions as an earth, which the mains earth may not always do for DC and low frequency AC and almost never for RF. So that if an installation demands an earth connection, a separate wire to a spearate earth stake is the only effective way.

W.A. Jolly,
Nambucca Heads, NSW

Info needed

I would be most grateful if you would allow me space in your excellent magazine to ask fellow readers for any service data, circuit diagrams etc., for a National three in one stereo unit MODEL S.G.000A

N.Smith,
Stanthorpe, Qld.

30W Stereo

continued from page 76

If all is well, check the other voltages shown around the power-amp chip (IC4), and the phono pre-amp stage (Q1, Q2 and IC1). When checking voltages around the circuit, don't forget that the heatsinks may be at the negative supply rail potential, and should not be inadvertently grounded. This will depend on the electrical, as opposed to thermal contact between the TDA1514A chips and the heatsink.

That's about it for the preliminary checks of the amplifier; there is no quiescent current to be set, no DC offsets to adjust, or thermal tracking to be checked. However, the TDA1514A chips (and the heatsinks) will normally be quite warm, so the unit should be monitored over a reasonable length of time for any limitations of the box ventilation. Also, the quiescent current of the TDA1514A chips will significantly increase if the power supply rails are beyond the recommended limit, which of course depends on the chosen transformer.

As a final check, connect a suitable input to the RCA sockets and check the controls and switches for their correct operation. After that, you are ready to experience the high performance of your new Playmaster 30-30 amplifier. EA

CD Reviews

continued from page 28

In the intervening 8 years he had grown from a relatively inexperienced composer to one with an increasing number of superb works to his credit.

The first set of dance has simple peasant gaiety and freshness, whereas the 2nd set has feelings of deeper emotion. Overall, the music like Bizets *L'Arlesienne* has virtually instant appeal and colourful orchestration.

This recording, which contains both complete sets is a new and dynamic one giving full justice to the composer as well as Dorati's skillfull conducting. The balance is first class with good presence and zero noise.

And excellent disc and at mid-price $19 a real bargain. EA

AWA Micro

continued from page 19

chine, and the workstations with a new Apollo DN4000. (A second DN4000 is used for controlling the Trillium test system.)

So there it is – Australia's very latest chip design and manufacturing plant. I don't know about you, but it certainly gives me a warm feeling knowing that we now have the latest chip fabrication technology right here in Australia.

The days of designing them here and then sending them overseas to be made (in due course) should be over. EA

Books

continued from page 137

ject, written for almost anyone with a basic understanding of electricity and electronics.

The author follows a largely chronological format, starting with Alexander Graham Bell's momentous invention of the first crude instrument in 1876 and gradually working his way through manual and automatic switching electromechanical systems, right through to modern computer-controlled electronic exchanges, cellular radio and data communications. And it's all explained in basic and easy to understand form.

Some of the fine details given to illustrate various concepts are fairly specific to the US scene, but this shouldn't detract from the book's basic value. If you're interested in learning more about telephones, the telecom system and how they developed, I think you'll find it well worth reading.

The review copy came direct from the US publisher. (J.R.) EA

50 and 25 years ago...

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

Wireless Weekly 3d

September 1938

Push Buttons Only!: It must be admitted that, for the non-technical listener who simply wants to hear what is on the air with the least possible trouble, the push-button system of tuning is ideal.

A logical development of this tendency is the dial-less set, with push-button tuning only, which has already firmly established its popularity in America, where most models of this kind are in the midget class.

The local market has already been pioneered along these lines, and now Slade's Radio has produced the full-sized mantel model illustrated above, tuned by the push-button system and designed for the reception of Sydney broadcasters only.

A New Radiola: AWA has announced the release of a further new Fisk Radiola Radio-Gramophone Combination Model 307.

This is a de luxe instrument comprising an electric tuning receiver and an automatic record changing gramophone. Technical features are similar to Radiola 4, with the addition of high-grade record-changing equipment, electrically given turntable and pick-up.

The cabinet of this new instrument is a magnificent console which is a triumph for artist designer and master cabinetmaker. Price, 120 guineas.

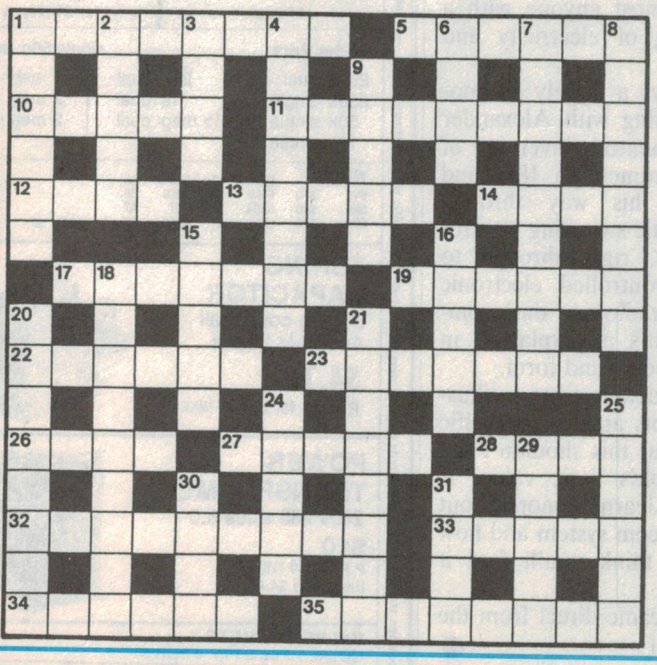
RADIO, TELEVISION and HOBBIES

September 1963

Faulty Insulators: Faulty insulators on high-voltage transmission lines can cause radio and television interference. Sparks occurring in cavities between metal fittings and the porcelain, between the line and the porcelain, or in cracks in the porcelain, act as primitive radio transmitters. The "signals" they transmit are picked up by receivers along with wanted signals.

An instrument for locating faulty insulators has been developed by Mr L. Medina, of the CSIRO Division of Applied Physics, University Grounds, Sydney, in the course of investigations on discharges in insulating materials. The instrument can distinguish between good and bad insulators two feet apart. Previously only the pole carrying the defective insulator could be identified. It can also be used to determine if a line is live or not.

SEPTEMBER CROSSWORD



ACROSS

1. Kind of plug. (5,3)
5. Characteristics of AC supply. (6)
10. Pin number for an octal plug. (5)
11. Scale of Terra! (4,5)
12. Potential unit. (4)
13. Region in junction FET. (5)
14. Conducting system, a twisted ----. (4)
17. What usually draws most from a car battery? (7)
19. Impede current. (6)
22. Air Force's appeal to technicians! (6)
23. Significant magnetic regions. (7)
26. Short electrical units. (4)
27. Household supply. (5)
28. A variable in colour TV. (4)
32. Elastic rule? (6,3)
33. Name of common symbol. (5)
34. Nature of semi-adjustable component. (6)
35. This pioneer had shocking results. (8)

DOWN

1. Volatge value for vehicle. (6)
2. Massive source of radiation in Orion. (5)
3. Etches. (4)
4. Converter of DC to AC. (8)
6. TV control. (4)
7. Gap seen in low-pressure gas discharge tube. (9)
8. Time to effect change between operational limits. (4,4)
9. Satellite's path. (5)
15. Remove data. (5)
16. State a brand of instruments. (5)
18. What's got four feet and a bill? (9)
20. Bigt project by Philips. (8)
21. Zero response tof the calls of 18 down. (2,6)
24. Proponent of exclusion principle. (5)
25. Kind of gauge that may use piezoelectric effect. (6)
29. Said of a theoretically perfect gas. (5)
30. Institution of Electrical & Electronic Engineers. (1,1,1,1)
31. Component of alarm system. (4)

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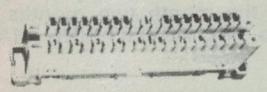

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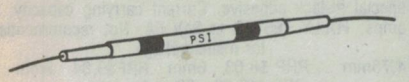

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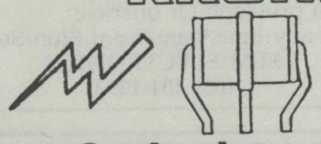

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EA Directory of suppliers

Which of our many advertisers is most likely to be able to sell you that special component, instrument, kit or tool? It's not always easy to decide, because they can't advertise all of their product lines each month. Also some are wholesalers and don't sell to the public. The table below is published as a special service to EA readers, as a guide to the main products sold by our retail advertisers. For address information see the advertisements in this or other recent issues.

Supplier	State	A	B	C	D	E	F	G
All Electronic Components	Vic	●	●	●	●	●		
Altronics	WA,NSW	●	●	●	●	●	●	●
Acetronics	NSW			●				
Chapman, Lance	NSW	●			●			
Dick Smith Electronics	All	●	●	●	●	●	●	●
Eagle Electronics	SA	●		●	●		●	
Electronic Brokers	Vic						●	
Electronic Component Shop	Vic	●		●	●	●	●	
Emona Instruments	NSW						●	
Geoff Wood Electronics	NSW	●	●	●	●	●	●	
George Brown Group	All		●		●	●	●	
Jaycar Electronics	Eastern	●	●	●	●	●	●	●
Pre-Pak Electronics	NSW		●		●	●		
Preston Electronics	Vic	●	●	●		●		●
RCS Radio	NSW			●				
Rod Irving Electronics	Vic	●	●	●	●	●	●	●
Scientific Devices	Vic						●	
Sheridan Electronics	NSW		●	●	●	●		
Tandy Electronics	All		●		●	●	●	●

KEY TO CODING:
A Kits & modules
B Tools
C PC boards and supplies
D Components
E IC chips & semiconductors
F Test & measuring instruments
G Reference books

Note that the above list is based on our understanding of the products sold by the firms concerned. If there are any errors or omissions, please let us know.

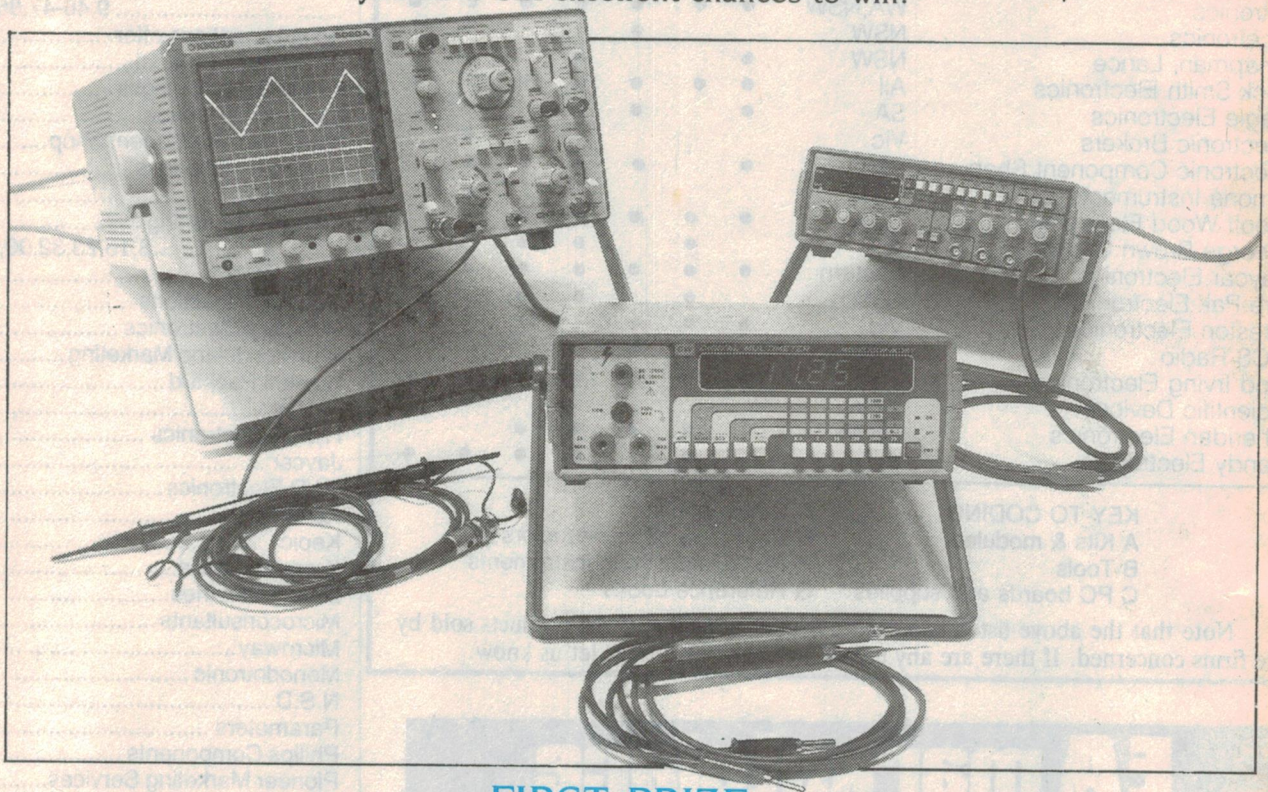
EA marketplace

ADVERTISING INDEX

$5,000 WORTH OF TEST

an EA exclusive

Here's YOUR chance to win these superb test instruments, valued at over $5200! All you have to do is subscribe NOW to Electronics Australia, Australia's leading electronics magazine, and you have SIX excellent chances to win!



FIRST PRIZE:

This great set of truly professional-quality test instruments from Emona Instruments will really look good in your home laboratory or workshop. Here's what you get:

- A *Kikusui* DSS-5020 20MHz *dual-trace oscilloscope with inbuilt digital storage facilities, valued at* $3500
- A GW *Instruments* GFG-8019 *multi-function* 0.2Hz-2MHz *function generator with inbuilt 6-digit* 10MHz *frequency counter and sweep generator, valued at* $644
- A GW *Instruments* GDM-8035T *high accuracy* 28 *range* 3-½ *digit digital multimeter, valued at* $400

TOTAL VALUE OF THIS MAGNIFICENT FIRST PRIZE IS THEREFORE $4544!

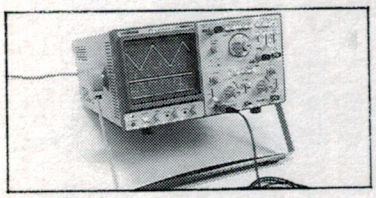
5 CONSOLATION PRIZES!!!

Obviously only one lucky EA *subscriber can win this first prize — and it could be* YOU. *But even if you're not quite that lucky, you could still win one of* 5 *consolation prizes, each consisting of a top-quality* Escort EDM-1122 *handheld digital multimeter with* 29 *ranges* PLUS 200kHz *frequency counting, capacitance measurements, transistor and diode testing, continuity and logic testing*

EACH CONSOLATION PRIZE VALUED AT.....$149

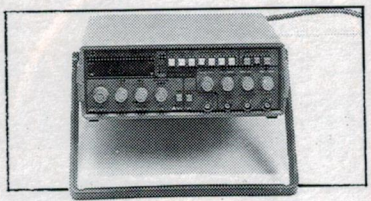
INSTRUMENTS TO BE WON!

FIRST PRIZE INCLUDES . . .



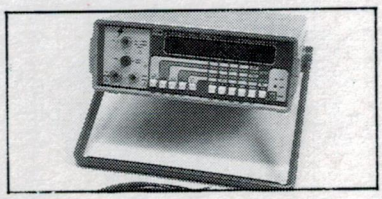
KIKUSUI DSS-5020A: DUAL TRACE DIGITAL STORAGE 'SCOPE

Normal mode — Bandwidth DC to 20MHz, 5mV/div to 5V/div — Timebase 50ns/div to is/div Storage mode — Bandwidth DC to 400kHz with 1MHz sampling — 8-bit sampling with memory of 1024 words per channel plus 1024 word REF display — 28 dot-div vertical x 100 dot/div horizontal resolution — linear or sinusoidal interpolation — simple pushbutton operation



GW INSTRUMENTS GFG-8019 MULTIFUNCTION GENERATOR

Generator frequency range — 0.2Hz to 2MHz. Output waveforms — sine, triangle, square, pulse, ramp. Output level — >20V p-p open circuit, 10V p-p/50 ohms. Frequency counter range — 0.1Hz to 10MHz (6 digits). Counter sensitivity — < 20mV RMS at 10MHz. Sweeping range — 1000:1 ratio. Sweeping modes — Auto/manual, lin/log, 0.5s-30s.

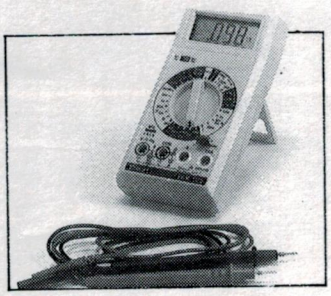


GW INSTRUMENTS GDM-8035T BENCH-TOP DIGITAL MULTIMETER

3-½ digit LED display, all ranges fully protected. Basic accuracy — 0.1%. DC voltage ranges — 199.9mV to 1200V (10M impedance). AC voltage ranges — 199.9mV to 1000V (True RMS). DC current ranges — 199.9uA to 20A. AC current ranges — 199.9uA to 20A. Resistance ranges — 199.9 ohms to 20M (6 ranges)

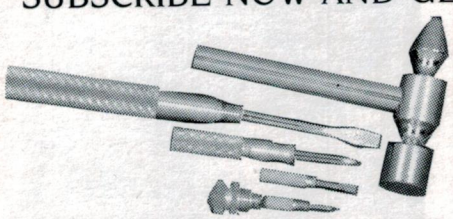
ESCORT EDM-122 HANDHELD DIGITAL MULTIMETER/COUNTER

3-½ digit LCD display (17mm high digits)
DC voltage ranges — 200mV to 1000V (5 ranges)
AC voltage ranges — 200mV to 750V (5 ranges)
DC current ranges — 200uA to 20A (6 ranges)
AC current ranges — 200uA to 20A (6 ranges)
Resistance ranges — 2000 ohms to 2000M (7 ranges)
Capacitance ranges — 2nF to 20uF (5 ranges)
Frequency ranges — 2kHz to 200kHz (3 ranges)
Other ranges — transistor hFE, diode VF, logic levels, audible continuity



(5 TO BE WON AS CONSOLATION PRIZES!)

SUBSCRIBE NOW AND GET THIS GREAT PAPERWEIGHT/TOOLKIT FREE!



Regardless of whether you win one of those great test instruments, by subscribing now you'll automatically receive one of these intriguing solid brass paperweights — which is also a handy 5-in-1 toolkit! Outside it's a hammer, but inside the handle there are four screwdrivers (two flat blades, two Phillips). Normal retail value $14.95!

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HURRY! THIS OFFER CLOSES 31ST NOVEMBER, 1988

CONDITIONS OF ENTRY

1. The competition is open only to Australian Residents authorising a new/renewal subscription before last mail Wednesday, November 30. Entries received after closing date will not be included. Employees of the Federal Publishing Company, Emona Instruments and their families are not eligible to enter. To be valid for drawing, subscription must be signed against a nominated valid credit card, or, if paid by cheque, cleared for payment. 2. South Australian residents need not purchase a subscription to enter, but may enter only once by submitting their name, address, and a hand-draw facsimile of the subscription coupon to The Federal Publishing Company, PO Box 227, Waterloo, NSW 2017. 3. Prizes are not transferrable or exchangeable and may not be converted to cash. 4. The judges decision is final and no correspondence will be entered in to. 5. Description of the competition and instructions on how to enter form a part of the competition conditions. 6. The competition commences on 24 August, 1988 and closes with last mail on 30 November, 1988. The draw will take place in Sydney on 2 December, 1988, and the winner will be notified by telephone and letter. The winner will also be announced in The Australian on Monday, 5 December and a later issue of this magazine. 7. The prize is: KIKUSUI DSS-5020 20MHZ dual trace oscilloscope with inbuilt digital storage facilities $3500 GW Instruments GFG-8019 multi-function 0.2 Hz-2 MHz function generator with inbuilt 6-digit 10 MHz frequency counter and sweep generator $644 & GW Instruments GDM-8035F high accuracy 28 range 3-½ digit digital multimeter $293. 5 consolation prizes of Escort EDM-1122 handheld digital multimeter $149 each. 8. The promoter is The Federal Publishing Company, 180 Bourke Road, Alexandria, NSW 2015. Permit No. TC/88/2324 issued under the Lotteries and Art Unions Act 1901; Raffles and Bingo Permits Board Permit No. 88.1441 issued on 12/8/88; ACT Permit No. TP88/832 issued under the Lotteries Ordinance, 1964.

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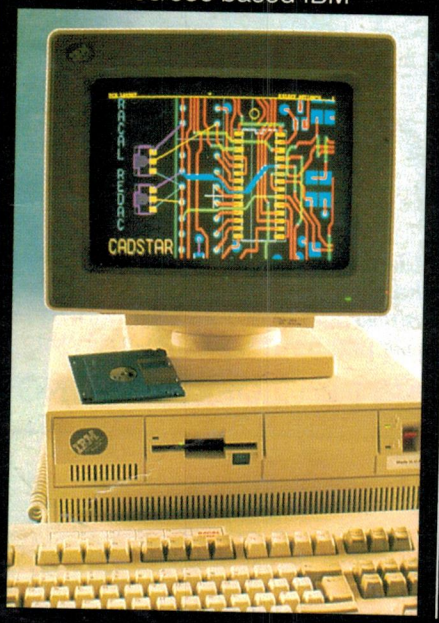

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